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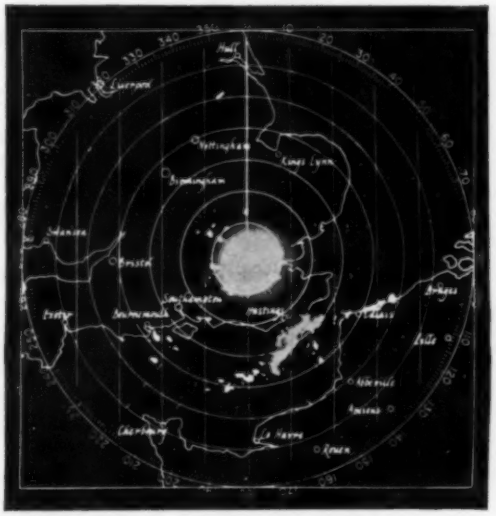

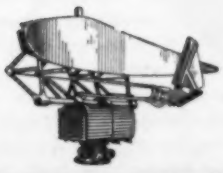

This actual picture, taken at the Meteorological Office from the Decca Type 41 Radar installed at the Air Ministry, Kingsway, shows heavy storms moving across the English Channel—on the 150 mile range scale.

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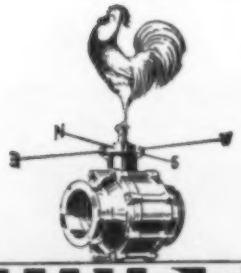

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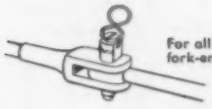

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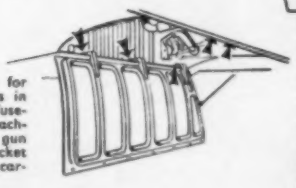

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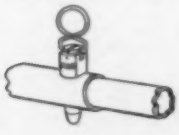

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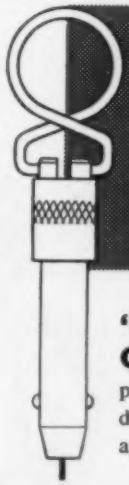

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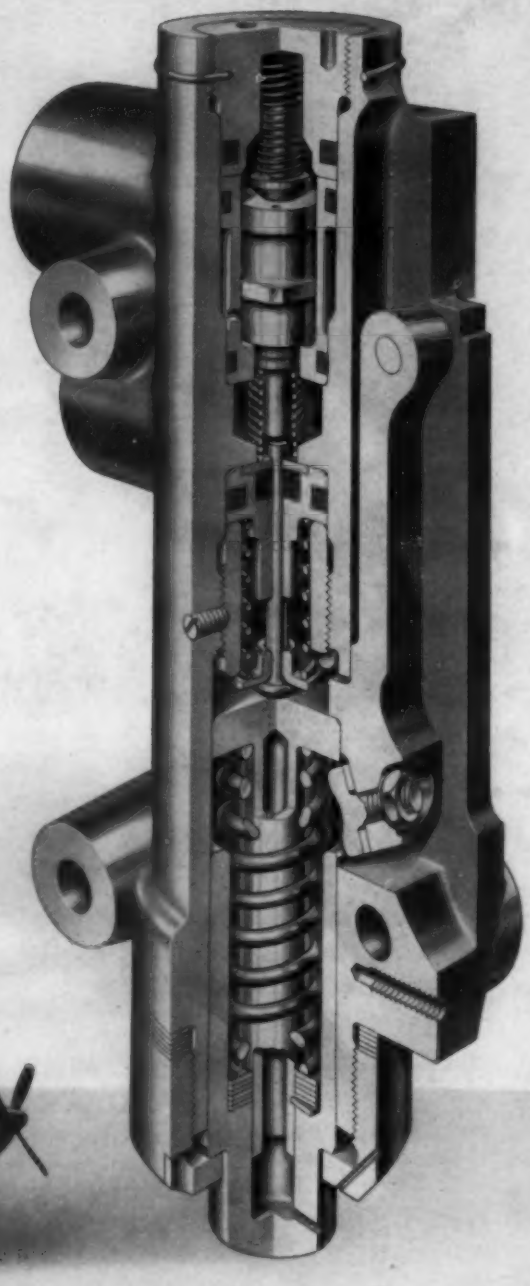

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

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and
AIRCRAFT ENGINEER

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H. F. KING M.B.E.

Technical Editor
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Looking to Laurels (and Lockheed)

IF we know our Americans, they will soon be seeking to take the shine off Peter Twiss's new record of 1,132 m.p.h., and we may "look to Lockheed for leadership" in putting an F-104 over the speed-course within a few weeks. We should be foolish to delude ourselves that this razor-winged fighter, with its 15,000-lb-thrust General Electric J79 turbojet plus reheat, is anything short of an exceptional achievement, and all signs point to it as the F.D.2's most potent rival. In the continuing absence of any official information, however, some doubt remains concerning its ability to carry sufficient fuel for the scorching periods of acceleration, and the measured speed runs, with full reheat. (The demonstrated ability of the F.D.2 in this respect—nine minutes with reheat and fifteen minutes without—is a matter for particular congratulation of the Fairey design team.)

Conjectural, too, are the F-104's stability at speeds substantially in excess of Mach 1.7 and its precision of control, though pilots speak of it as something of a dream-ship.

Should the laurels eventually pass to this most "hush-hush" fighter of all time, it may well be possible for the makers (and the U.S. Air Force, for which it has been built) to claim it as a standard production fighting machine, carrying its normal built-in armament of the so-called "Gatling gun", or multi-barrelled Project Vulcan, of prodigious rate of fire.

Unfortunately (we use the word in a purely sporting sense, recognizing that the new American fighters are master weapons in the Allied arsenal) the F-104 is not the only rival of Fairey's delta. In the Crusader, for example, Chance Vought and the U.S. Navy have a machine of uncommon merit and very great speed, and one which, being built to naval requirements, should satisfy the fuel demands of a record attempt. Then there is McDonnell's F-101 Voodoo, a monster fighter which should likewise be able to stow sufficient wide-cut "gas" in its 67-foot fuselage to slake the record thirst of two reheated Pratt and Whitney J57s.

But apart from these technical considerations there remains the pilot's personal responsibility of holding height within the hundred-metre vertical tolerance. Of this ordeal we will only remark that, even should America prove to have built a faster aeroplane than ourselves, better pilots than Peter Twiss just do not come —west or east of the Atlantic.

Matching Men to Machines

THOUGHTS of pilot-quality remind us that the visit to a Valiant squadron (of which we shall have much more to say next week) was productive of news of the men rather than the aircraft. War-trained skippers will note the current requirements with respect: 1,750 hours as first pilot (which means over 2,000 hours total); "above average" flying ability; green jet instrument rating; "highly recommended" by parent unit. Should a selected pilot not have served with a Canberra squadron, then he must undergo the Binbrook course and be posted to one; and when he finally gets on to Valiants he will remain with his appointed squadron, regardless of promotion, for five years. One hundred per cent is the target in his examinations; so he will be well equipped to conduct his million-pound aeroplane (the most costly ever to enter R.A.F. service) in safety, and "pilot error" is unlikely ever to be laid to his charge.

Though such rigorous training and uncompromising selection has long been the order of the day in the U.S.A.F. Strategic Air Command, it is something quite new to the R.A.F., and the feelings of the commanding officer at Gaydon, the Valiant O.C.U., can well be understood. The Valiant, he remarked, is "a fair-sized flying power house": we could not afford to have such a large proportion of the nation's resources damaged through the ignorance of the crew (for qualifications of the same standard are laid down for other Valiant flying personnel). Thus is the R.A.F. meeting a new challenge.

FROM ALL QUARTERS

RUSSIAN REVELATION: The Tu-104 jet transport which brought Gen. Serov to London Airport last Thursday. First-hand appraisal—page 372.

Yet More Viscounts

SINCE the Viscount order book passed the 300 mark (*Flight*, March 23rd) the purchase of a further eight aircraft has been announced. In Cologne on March 19th Lufthansa stated that orders for seven Viscount 810s "would be placed shortly" for delivery in 1958-59 to take over the company's Convair 340 routes, and on the same day Iraqi Airways came forward with a repeat order for one Viscount 700 to add to their fleet of three. The aircraft which, as announced last week, brought sales from 298 to 301 were three Viscount 700Ds for the Persian Government, two of which will be used as airliners and the third for the personal use of the Shah.

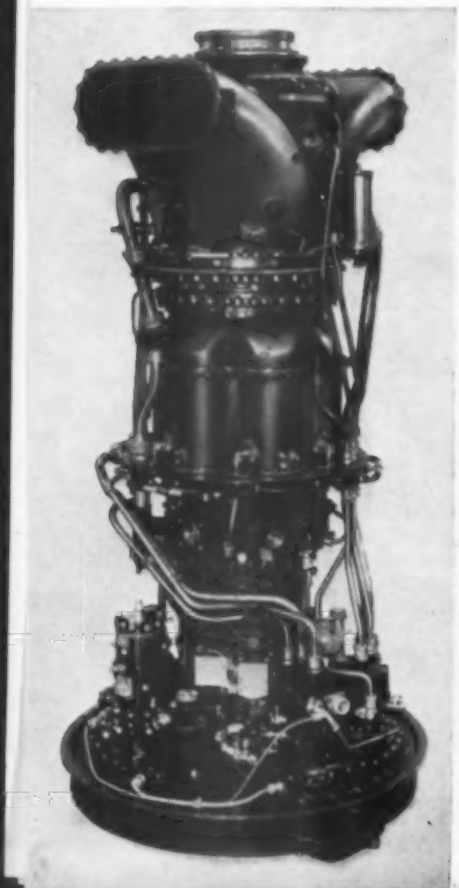
Napier's Gazelle

REVEALED last week, the 1,260 h.p. Gazelle free-turbine engine promises to be one of Britain's most successful engines, and a solid "bread-and-butter" unit for its designers and manufacturers, D. Napier and Son, Ltd. Its first run was two months ahead of schedule, and it is the first engine ever to exceed its brochure performance on its initial calibration runs. Over 100 bench-hours have now been run, on a Ministry of Supply development contract. As the photograph shows the Gazelle is very compact, and it will normally be mounted vertically, standing some 70in high. Air is taken in around an inward-radial intake, passes up through the efficient single-spool compressor and the cannular combustion chamber (a departure from previous Napier practice), drives the compressor and power turbines and leaves through a bifurcated jet pipe. The shaft power is extracted from the output of an epicyclic reduction gear flexibly mounted on the upper end of the turbine shaft and located between the jet-pipes.

Accessories are very easily reached for servicing on the upper face of the intake casing. The Gazelle is fitted with Napier's single-lever control system of the pattern already popular on the company's other engines, and the free-turbine layout should make it a very "flexible" unit from the pilot's viewpoint. Incorporated in the fuel-metering unit are limiters on turbine-inlet temperature and torque and compensation for changes in ambient temperature and pressure.

Already the Gazelle is scheduled to power two very important helicopters: the single-engined Westland Wessex for the Royal Navy and the larger Bristol 192 for the R.A.F. (with considerable civil prospects). In the latter a Gazelle will be mounted directly under each of the mechanically coupled tandem rotors, and flight will be possible on either engine.

At present the NG.1 rating is 1,260 shaft horse-power, but steady development is expected to raise this figure to at least 1,500 h.p. Napier certainly have a most valuable product in the Gazelle, and American interest in it is described as "most encouraging." In America its only competitors will be the lower-powered Lycoming T53 and the roughly comparable General Electric T58.



Napier's new Gazelle free-turbine powerplant is already earmarked for the Bristol 192 (mounted vertically, as shown here) and the Westland Wessex.

Sycamores for Germany

ACCORDING to "an informed source" quoted in Bonn, the West German Defence Ministry is soon to order eight Bristol Sycamore helicopters at a cost of about £45,000 sterling each. Further orders, it is reported, may follow.

A.A. in the Air

DURING the coming Easter week-end the Automobile Association is to make further experiments in air/radio surveillance of its road-patrol service. Though light aircraft are envisaged for any future scheme, this particular exercise will utilize a chartered Consul, as a number of observers will be carried.

Bill Stout Dies

ONE of the most colourful personalities on the American aeronautical scene, Mr. William Bushnell Stout—Bill Stout to thousands—died in Phoenix, Arizona, on March 20th.

Born in 1880, he was aviation editor of the *Chicago Tribune* as early as 1912, and founded *Aerial Age* magazine. As chief engineer of the aircraft division of the Packard Motor Company and technical adviser to the aircraft board in Washington during the First World War, he developed his ideas of aircraft construction and built America's first internally braced cantilever aircraft. This principle of construction was used in a torpedo machine of the early 1920s and in a succession of commercial aircraft, notably the famous Ford Trimotor.

Bill Stout's famous saying, "Simplicate and add more lightness," has long been a precept in drawing offices the world over.

International Gliding Conference

SIXTH congress of OSTIV, the international gliding research organization, will be held at St. Yan during the second week of the world gliding championships, from July 6th to July 14th. Technical and meteorological papers will be read, and it is hoped to arrange comparison flight-tests after the championships similar to those held at Orebro in 1950. Both performance measurements and assessments of handling qualities will be made. Further details of the congress are obtainable from the British representative of the organisation, Mr. A. H. Yates, B.Sc., B.Sc.(Eng.), A.F.R.Ae.S., at City of Bath Technical College, Lower Borough Walls, Bath.

The effect of the prone position on fuselage cross-section and on canopy size are well shown by this close-up air-to-air view.

Handling the Prone-pilot Meteor

Flying a Jet Aircraft Head First

By C. M. LAMBERT

FOR centuries man has been accustomed to being conveyed from place to place in a sitting position. When the aeroplane came along, the pilots—with some notable exceptions, such as the Wright brothers—kept to the sitting position and found it efficient and natural; so natural in fact that any other attitude is now regarded as strictly unconventional, despite Mother Nature's strong hint in favour of the head-first position which she has specified for all normal bird flight.

Never having driven anything on my stomach but a toboggan —and that a good many years ago—I accepted with alacrity the opportunity of flying Armstrong Whitworth's Prone-pilot Meteor. Vaunting a modest 380 hours in Meteor day fighters, I therefore presented myself at the Institute of Aviation Medicine, Farnborough, and prepared to fly this Meteor on my stomach, not without considerable misgivings about the sensations it might provide. But, knowing the Meteor well, I found it no more difficult to fly lying down than sitting up. The experience was noteworthy, however, if only because a journalist has not previously been privileged to fly a jet aircraft in this way.

Before discussing impressions of flying, a description of the layout of this particular aircraft is necessary. The first Farnborough venture in prone piloting was in the Reid and Sigrist Desford, which was converted in much the same way as the Meteor by the addition of a new cabin in the extreme nose. Here, however, there was not enough room to allow rudder pedals, and the controls for all three axes were incorporated in a spectacle-wheel control column with three degrees of freedom. This made the machine somewhat difficult to fly. The next stage was the Meteor, which Armstrong Whitworth prepared so that the Institute of Aviation Medicine could investigate the characteristics of the partially prone position—for the Meteor bed is only partially horizontal. The longest nose compatible with aerodynamic requirements was added ahead of the standard cockpit so that fairly generous dimensions could be used; but, even so, the tallest people could not be catered for. A check pilot flies in the ordinary cockpit at all times. The bed was arranged as shown in the diagram overleaf, with electric screw-jacks so disposed as to alter the eye level, thigh length, thigh angle to the body and rudder-pedal reach.

The feet must be held on the rudder pedals, so these were given raised edges which prevent the feet falling away. Once in position the pilot cannot see his feet at all, or do much feeling around if he loses the pedals. A rest projecting rearwards between the thighs serves to support the seat-type parachute pack in its position against the pilot's posterior, and a trough along the section of the bed supporting the trunk accommodates the main parachute release box. The forward end of the bed is curved upwards to conform with the chest line of the average man, and terminates in a vee-shaped foam-rubber chin rest. The arms naturally hang down on either side of the bed and the elbows rest on padded ledges, whence the forearms reach forward to the controls.

The rudder pedals are hinged at their upper ends, so that control movement is by pivoting the feet about the ankles. Arm movement is more or less limited to that normally available if the elbow is rested firmly on the arm of a chair. By reference to the diagrams it can be seen that the range of movement and leverage available in this layout are small—certainly not large enough to cope with any great control forces such as are found in normal Meteors. The prone-position Meteor was therefore given hydraulic boost on all control surfaces through Fairey Hydroboosters placed near the surfaces. Feedback of aerodynamic loads to the cockpit is 10 per cent on the ailerons, 20 per cent on the rudder and 40 per cent on the elevator. This has brought the forces at the front control column grip back to a level slightly lower than that of the Meteor 8.

Because of the length of the extended nose, a Mk 12 fin was added to maintain stability, but the travel of the rudder was limited.

On the score of personal comfort the prone-position Meteor is quite well provided. The cushioning is really soft and quite deep and the elbow rests are effective and clear of sharp edges. But lying on one's stomach is not really very comfortable in any case and I found it difficult to decide quite how to support myself —whether I should shorten the thigh length to take a lot of weight on the knees, and whether I should lower the eye level to take weight on the elbows. The ideal compromise is to arrange lengths and heights so that weight is as evenly as possible distributed over every part of the body, leaving no muscular tension to take the place of support.

Most controls are laid out on a flat shelf immediately in front of the bed. By exerting myself I found I could just reach the windscreen, but not apply enough pressure to it to scrape off some ice which formed there after the let-down. The V.H.F. selectors were just accessible, but could in any case be controlled from the rear cockpit. Flap, undercarriage, trim, air-brake and engine power controls are the same as those of the Meteor fighter and, being rather stiff, are difficult to operate. Most of these would, in a new design, obviously be made electro-hydraulic and criticism here is not valid for the prone position. It shows only that the pilot on his stomach is effectively greatly weakened.

In the prone position, the instruments are much closer to the face than normally, and the panel has as far as possible been sloped to avoid parallax errors in readings. This was not however possible with the gyro instruments, and they are recessed between pressure instruments on a vertical panel. The standard six-instrument layout has been approximately preserved. A g-meter prominently mounted close before the eyes tends to obscure the artificial horizon, and I had to lower the eye level right down for instrument flying. Adjustment of the bed attitude is controlled by four switches grouped on the shelf, in a position where they can no longer be seen after one is strapped in with the oxygen mask on. A little manipulation soon produced the

(Left) The prone pilot's cockpit sticks out like a blistered proboscis from the standard Meteor 8's fuselage. The fin is from a Mk 12 and rudder movement is restricted. All controls are powered.

(Right) S/L. R. S. Wambeek of the Institute of Aviation Medicine, the author's patient check-pilot.

HANDLING THE PRONE-PILOT METEOR . . .

desired results, however, as the sections of bed can be felt moving quite rapidly under one.

The prone cabin is not pressurized and there is no partition between the cabin and the nosewheel bay. Things became pretty chilly in consequence, but not much more so than the front seat of a Meteor 7 with the old heating system. A strong supply of warm air could be blown from tubes on to the windscreen, but at full throttle this produced a certain amount of acrid smoke, and jets of dusty air converged on my eyes and forced me to close them when I needed lots of hot air to clear the windscreen of ice.

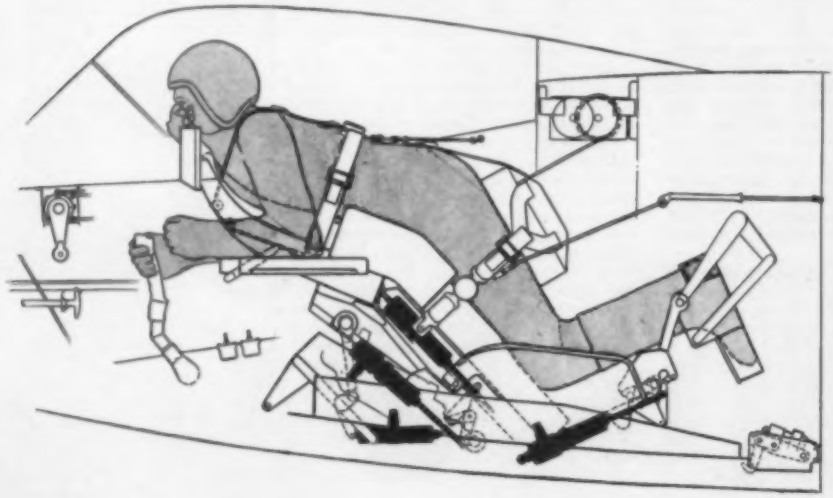
Most of the above I ascertained during an initial trial of the cockpit under the guidance of S/L. R. S. Wambeek, of I.A.M., who was later to occupy the normal rear cockpit and monitor my efforts. The escape drill was the next item to be explained to me and, because of its comparative novelty, it is worth recording. Upward ejection for emergency escape in the prone position is obviously impossible and Armstrong Whitworth accordingly arranged for the pilot to be dropped out from under the nose. The hood would remain closed throughout escape proceedings. When the decision to abandon is taken, the first step is to pull the lever on the right marked "Prepare to escape." This causes the rudder pedals to swing back out of the way, releasing the feet; the ventral tank is jettisoned and the nosewheel, if not already up, is blown into the retracted position by an air bottle. Next another handle, below the lever, is pulled and the bottom of the cabin, together with the lower part of the bed, is forced out into the airstream by a hydraulic ram. The pilot is then virtually hanging downwards out of the cabin, but shielded from the airstream. Finally he presses a lever on the front of the couch which releases the harness and allows him to fall feet-first into the airstream. The opening of the parachute is controlled by a barometric capsule stowed in the pack, and this is triggered by a 10ft 6in static line fastened to the aircraft. The barostat is set to operate at 13,000ft and minimum safe escape altitude is stated to be 400ft. The upright pilot has the old Mk 1 Martin-Baker seat, for which 2,000ft is considered a safe lower limit.

Whether to drop out of this aircraft or stay with it is a nice question, and action must be considered in the light of the extremely exposed position of the nose cabin. Brake failure or some similar mishap causing the Meteor to roll fast off the end of the runway is in many ways the most unpleasant prospect, though landing with one wheel up comes a very close second indeed. Anyhow, this eventuality has not arisen, and is unlikely to do so before the machine is stored or reconverted to Mk. 8. The I.A.M. completed its assessment of the machine last year.

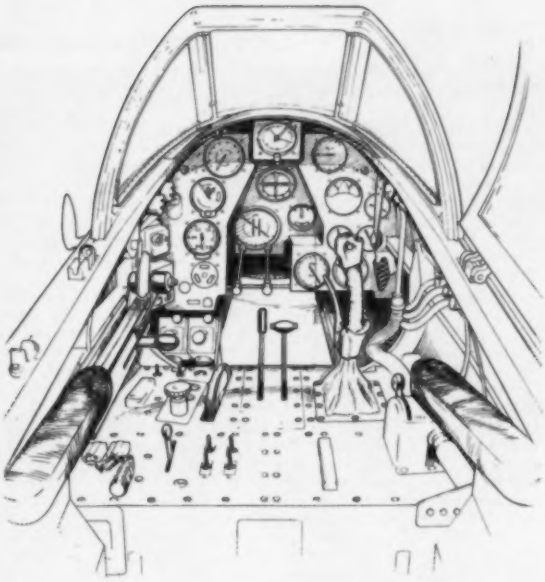
At first sight the depth of the prone-position cabin and the proportions of the windscreen seemed extremely small, but then that was the object of this layout. A large canopy is always a great aerodynamic problem and it was partly to reduce the size of this section that the prone position was advocated. Yet the cabin seemed to be full of bed, almost up to the coaming. I put on one of the new lightweight flying suits and a seat-type parachute, climbed up a step-ladder and worked my way gingerly down on to the bed, first positioning my feet against the pedals, then lying down and finally putting my hands through the gap between body rest and cabin wall into the space ahead of the bed. I could not raise my arms without withdrawing them again through the gap. To do so I had to raise my chest by tensing the muscles in the back, and at first this required some effort. I put on a standard cloth helmet and oxygen mask and plugged the oxygen pipe into a union by my right cheek and the R.T. lead into a socket close to my left cheek. I was then irretrievably prone and willing hands fastened the straps (over my shoulders, back and parachute pack) which stopped me moving up, forward or back on the bed. The static line was connected to the pack and finally the hood was shut over me.

Engine starting, radio and powered flying-control engagement were all controlled by S/L. Wambeek in the rear cockpit, so I lay still for a minute while everything was started up. All controls and instruments were effectively distributed within the area covered by the windscreen structure and, though everything was close to eyes and hands, there was no lack of light or feeling of confinement. With my chin on the rest the field of visibility was strictly limited to what I could take in by rolling my eyes. This gave full view of instruments and most controls, excellent forward visibility and a good view downwards through the window in the cabin floor, but virtually no view sideways or upwards. I could, by raising my head with some effort, see just above the bridge of the windscreen or, by resting my chin on one of the horns of the chin rest, see sideways to some extent; but there was nothing like any rearward visibility. For many operational rôles this would not, of course, be required.

As soon as we had cleared the hardstanding and were on the



The four electric screw-jacks shown here control the eye level, angle of thigh to body, thigh length and rudder pedal reach. Control is from the switches shown below the pilot's forearms. The static line, 10ft 6in long, is attached to the barometric capsule in the seat-type parachute pack and wound on the drum close by. There are two main harness junction boxes which can be released by depressing a lever on the front of the couch. Pulling the top lever under the windscreen withdraws the rudder pedals rearwards, jettisons the ventral tank and retracts the nosewheel if it is down. Pulling the plunger below the lever causes a hydraulic ram to swing the rear half of the bed down and out into airstream so that the pilot can drop clear as soon as he unfastens his harness.



The working end of the prone-position cockpit. Instruments and controls are similar to those of the standard Mk 8, but are re-arranged. The gyro instruments are on a vertical panel, and others on sloped panels on either side. A g-meter is mounted centrally, directly before the pilot's eyes. The adjustment knobs for the G.4 gyro-compass have been extended within reach of the pilot. Main controls, reading across the horizontal shelf, are V.H.F. selectors and controllers, rudder and elevator trim wheels, undercarriage and flap levers, control column and windscreen demisting air control. The four switches grouped in the foreground are for bed adjustment.

perimeter track, S/L. Wambeek handed over control to me. As we rolled along I felt a little as if I were tied to a springboard in front of a lorry, but the ride was smooth. The Meteor is not a particularly easy aircraft to taxi because of the slowness of engine and brake response, but I found that the prone position gave no more than momentary uncertainty in rudder-pedal operation. Difficulty arose from the pedals being close together and the long travel available led to a tendency to over-control. Though one does get a very intimate view of the tarmac, there is no violently unnatural sensation while all three wheels are in contact with the ground.

The first anomaly was on lining up for take-off, when I found it difficult to judge the neutral position for the very short stick without making a full fore-and-aft swing and then selecting the central position arbitrarily. Power-lever movement was quite natural, but the acceleration during take-off tended to pull me back off the bed.

I kept the aircraft decently straight on the runway but, being unused to the power boost, I raised the nosewheel a little abruptly at just over 80 kt. At 120 kt the main wheels left the ground and I had the first feeling of over-sensitive ailerons as the power boost made itself felt for the first time. The centre position was a little difficult to find and the rate of roll high. I did not really get used to this characteristic throughout the flight. For the first few minutes I found the attitude relative to the horizon a little difficult to judge and made ample use of instruments in setting up the climb. The sensation of going up head first was very pleasant, however, and I immediately felt the urge to do some low flying. Apparently this is very thrilling in the prone position, though turns on to a given point are difficult to judge, because of shortage of upward visibility in a steeply banked turn. A Rate 1 turn in a Meteor requires some 45 deg angle of bank.

"Flight" photograph

The author ready to be strapped into position.

We pushed on through the haze and up through a gap in the clouds and sailed out into open sunlight at about 5,000ft. I kept on climbing up to about 10,000ft, making a turn towards the west, and levelled off to get the feel of things. Apart from having to become accustomed to a new position of the horizon against the windscreen there was no particularly strange sensation, but the feeling of wanting to press on head-first still prevailed and I was longing for something to bounce—though from the tactical point of view, I was not happy about the lack of rearward visibility. I made a few gentle turns and then tightened them up to about 4 g without any sign of blacking out. Here, however, the pressure of g, instead of being spread over the body and reduced as I had expected, acted equally at full force all the way down my front and exerted considerable pressure at the base of the rib cage. Automatically I tried to look behind me as I turned, but this required tremendous effort. I did not mind this at the time, as my back muscles are fairly strong, but the following day I suffered considerable stiffness between the shoulders. It would take only practice to get used to this. Repeated turns at moderate g caused considerable discomfort from pressure on the upper body, but one is so used to such things in other aircraft that I feel I failed to readjust the bed to give the best relief in this case.

I was taking a good deal of weight on the elbows and shoulders. The prone-pilot Meteor is however very manœuvrable, particularly in roll, and it was pleasant to throw about, though I fear I gave little thought for S/L. Wambeek in the back seat. He was very patient.

I next tried some rolls and found that the prone position felt much more natural in this plane of manœuvre than the usual upright attitude. I suppose the medical men would disagree, but I did feel that one is much more liable to plain giddiness when prone and rolling fast like a corkscrew rather than upright and whirling like a conker on a string. Throughout this flying the stick forces at the grip of the short control column felt slightly lighter than in a Meteor 8, but response was far better in the rolling plane. The general feel of the machine was very much the same as that of the day-fighter version, except that snaking, when it developed, was pronounced. I managed to counteract one particularly strong snake for some seconds before it took its own head—an unusual experience since it is normally best simply to clamp feet on the rudder pedals and try to prevent the rudder from moving.

At last, at about 20,000ft, I found the lone Meteor 8 which was stooging in readiness to be attacked. He was well within my limited field of view and I made a gentle level quarter attack from starboard and broke off at about 300 yd. Turning away, I had no idea whether he was following me round; but when I was again in a position to see him he was still going straight on, and I made another gentle quarter attack from above. This time he pulled his air brakes as I came in, but still he did not break and I left him to it and pulled away over the top of him. With the limited visibility of the prone position it is quite feasible to make such an attack on another aircraft, so long as it is always kept in front and not lost to view above the windscreen bridge.

I next made a Mach run up to 0.8 Mach at 20,000ft. The normal strong nose-up trim-change set in at about 0.76 but could be held fairly comfortably with the powered elevator. There was really no difference between this and the Meteor 8 and I was getting used to having my neck bent back and not seeing too much. Pulling the air-brakes and throttling back gave plenty of deceleration, as always, but no odd sensations resulted. From this run I went straight back to the stall, which came with slight burbling at about 115 kt. The Meteor's stall is completely straightforward, neither wing nor nose dropping, so recovery again produced no unusual sensations.

Aerobatics were the obvious next step—and the most intriguing trial of the prone position. Rolls I had already done and found more pleasant prone than otherwise, so I wondered what the loop had in store. I dived to 380 kt. This was a little faster than normal for a loop, because it would have been undesirable to risk running out of speed at the top (the aircraft had not been spun, so its characteristics with the long nose and restricted rudder movement were not known). I made a normal pull-out at about 4 g, feeling the pressure on the chest quite strongly, but with no sign of black-out. In characteristic way the Meteor bored up and up and slowly over and down again. The normal height range of a loop is about 5,000ft. The trick is to keep the horizon in sight in order to fly the aircraft accurately all the way round. In the prone position I had my work cut out, peering sideways as I went up and straining backwards as I came over the top. Here, however, I was able to make use of the window in the floor for the first and only time. Through it, as we went vertically upwards,

HANDLING THE PRONE-PILOT METEOR . . .

I could see the horizon and adjust the course of the climb. The main feature of the loop was the restriction of visibility and the absence of any tendency to black out, despite starting at 380 kt at about 15,000ft. A roll off the top was next, and for this I gathered a full 410 kt at 14,000ft. Half way up I glanced at the g meter and saw the maximum-reading needle at 6 g with no sign of black-out; 6 g is the maximum permitted on this aircraft. Over the top S/L. Wambeek told me when we were level, and I rolled out without difficulty.

Finally I rolled over and held the aircraft inverted for some seconds. My weight was taken on the straps at shoulders, waist and thigh and I began to feel a trifle unpleasantly divorced from the machine. Instead of having my head sticking out from under the top of a cockpit, so to speak, I felt rather that the whole machine was poised above me. It suggested a smoother version of the Cossack trick of riding under the belly of a horse.

I was now beginning to feel some pain from cold in the feet, and was not a little tired from applying g on an unhardened chest; we had in any case been airborne for some 30 min and wanted to try some roller landings; so we made a controlled descent through a thin cloud layer. With dive brakes out and at 11,000 r.p.m. the Meteor goes downhill quite sharply at about 5,000 ft/min. Lying down the sensations are no more marked than when sitting up, and consist mainly of a loud popping of ears if the tubes are not quite clear. A small part of the descent was on instruments and there was no trouble there, but I would reserve an opinion on prone instrument-flight until I had recovered from some unusual attitudes, done a good deal of flying on primary instruments and successfully repeated the obnoxious "twizzle" (precision climbing turn on instruments).

We joined circuit on the runway QDM and turned for a long down-wind leg. Flap was lowered one-third at 200 kt and air-brake retracted and wheels lowered at 175 kt as per routine. I could just see the runway from the downwind by craning, but as soon as I began the turn-in for a curved approach it was completely lost from view. It appeared again when we were on finals about 50 deg off the QDM and going down at 150 kt with full flap. I had been warned to allow for restricted rudder, directional characteristics and high weight by keeping 10-15 kt more over the hedge than usual, but overdid it a little and spent the first roller floating gaily down two-thirds of the runway before opening up and getting my stomach clear of it again. It was difficult to judge the aircraft's attitude in the final part of the approach and the height of round-out was strange. It felt as if we were diving quite steeply down and I could see a great deal more of the area just short of the runway than is normally the case. For the second roller I was advised to try a straight final approach, but here the point of the final turn was hard to judge, because of the difficulty of seeing sideways. But this time we made a normal touch-down and rolled some way before going round.

"Flight" photograph

The bed occupies a very prominent position in the cockpit. All controls and instruments are ahead of it in the space under the windscreen bridge. The striped handle is the "prepare to escape" lever. The chin-rest is covered in white chamois leather and the narrow trough down the centre of the couch accommodates the parachute-harness release box. The two shoulder-straps are laid out on the bed.

The final landing was normal and judgement had settled down to cope with the unusual attitude on the approach. I held the nosewheel up after touchdown until the regulation lowering speed of about 70 kt. There was a slightly odd sensation as the nose finally came right down. I had to concentrate on the rudder pedals during braking, but turning off and taxying were easy enough. One feels much more irretrievably "landed" after slowing down in the prone position, and is inclined to settle gratefully into the cushions, only to be alerted again for taxying with the curious rudder pedal arrangement. I was thankful for the hand-operated brake valve—toe brakes would have needed the mind of a conjuror who can do things behind his back, or of someone who could work a harmonium. Those rudder pedals might prove much more difficult if they really had to be used in the air; but, fortunately, they can be left more or less alone.

When, in dispersal, the static line and harness had been undone, I clambered down the step-ladder and assumed once more an upright position. My feet were quite numb with cold and my ribs felt a little sore, but considering that we had pulled a fair amount of g I was feeling quite fresh. S/L. Wambeek, who had made the flight in the upright position, felt the fatigue which is normally caused by a flight of this kind. I am not sure whether I would prefer to be tired or sore; but I should dearly love to get into the prone-pilot Meteor again and go low flying.

PRONE TO PHOTOGRAPHY

IN the opening paragraphs of the preceding article mention is made of the first Farnborough venture in prone piloting—the conversion of the Reid and Sigrist Desford trainer by the installation of a special control position in the extreme nose.

By an odd coincidence, as that particular page was going to press, the Desford cropped up again after nothing had been heard of it for several years. It has been acquired from the Air Ministry by Air Couriers, Ltd., who had realized that with its generous "glasshouse" nose and lively performance (something like 166 m.p.h. cruising, 176 m.p.h. top, when Gipsy Major 10s have replaced the two Gipsy Major 1s) it would make a thoroughly useful photographic aeroplane.

Designed and built towards the end of the war by Reid and Sigrist, the instrument firm, the Desford trainer embodied experience which the company had obtained from operating five flying training schools. Towards the end of 1951, the Ministry of Supply released a photograph (*Flight*, November 23rd, 1951) showing the Desford with its new transparent nose, adding the guarded information that it was "being used for experimental flying with a prone-pilot position."

A recent photograph of the Desford at Croydon.

DECCA DISCUSSED

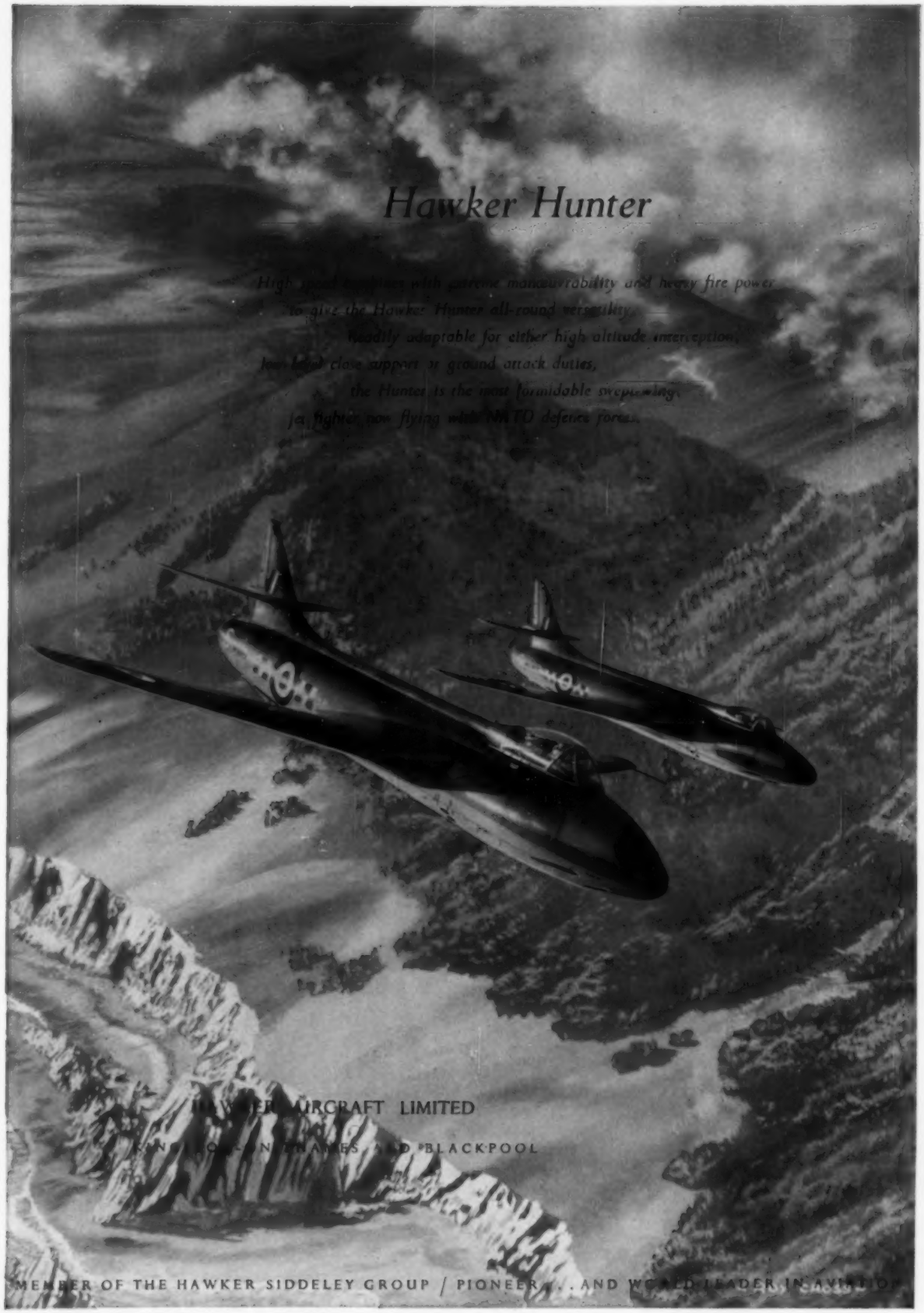
THREE papers, under the general heading of *Developments of the Decca Navigator System*, were given at the Institute of Navigation meeting held at the Royal Geographical Society, Kensington, on March 21st. The first, *Experiences with Decca on Viscount Operations in Europe*, was presented by a senior pilot of B.E.A.'s Viscount Flight, Capt. E. R. Wright; the second (*The Development of Dectra as a Long-range Navigational Aid*) was by Mr. H. G. Hawker, of the Decca Navigator Company; and the third was also by a member of that company, Mr. J. G. Adam, and was entitled *Developments in Decca for Helicopter Operations*. (In Mr. Adam's absence Mr. G. Hinchliffe read his paper.)

Speaking of the Decca system from the viewpoint of the practical pilot, Capt. Wright took his hearers on a simulated flight over France and Germany with the help of illustrations taken from an actual Flight Log chart. He emphasized that, once a pilot was accustomed to its operation, the system was essentially simple to use, adding that ground-speed checks facilitated by the Flight Log made an accurate E.T.A. very easy to predict.

Mr. Hawker discussed the development and projected trials of Dectra, the company's new long-range system intended for use as an aid for jet transport aircraft on transatlantic routes. After describing the principles of Dectra the lecturer went on to consider the predicted performance and arrangements for the trials.

Mr. Hinchliffe (Decca Navigator Co.) then read Mr. Adam's paper. The author, after reviewing the particular characteristics that made the Decca Navigator especially suitable for helicopter operation—for example, low-altitude coverage and pictorial presentation—referred to the accuracy requirements specified by the I.A.T.A. meeting on helicopter operations early in 1955, with particular reference to the problem of accurate tracking. It could be shown that over practically the whole of the British Isles the system as it stood had the required degree of accuracy.

The meeting was under the chairmanship of Capt. A. M. A. Majendie. We hope to report the papers and the subsequent discussion more fully in our next issue.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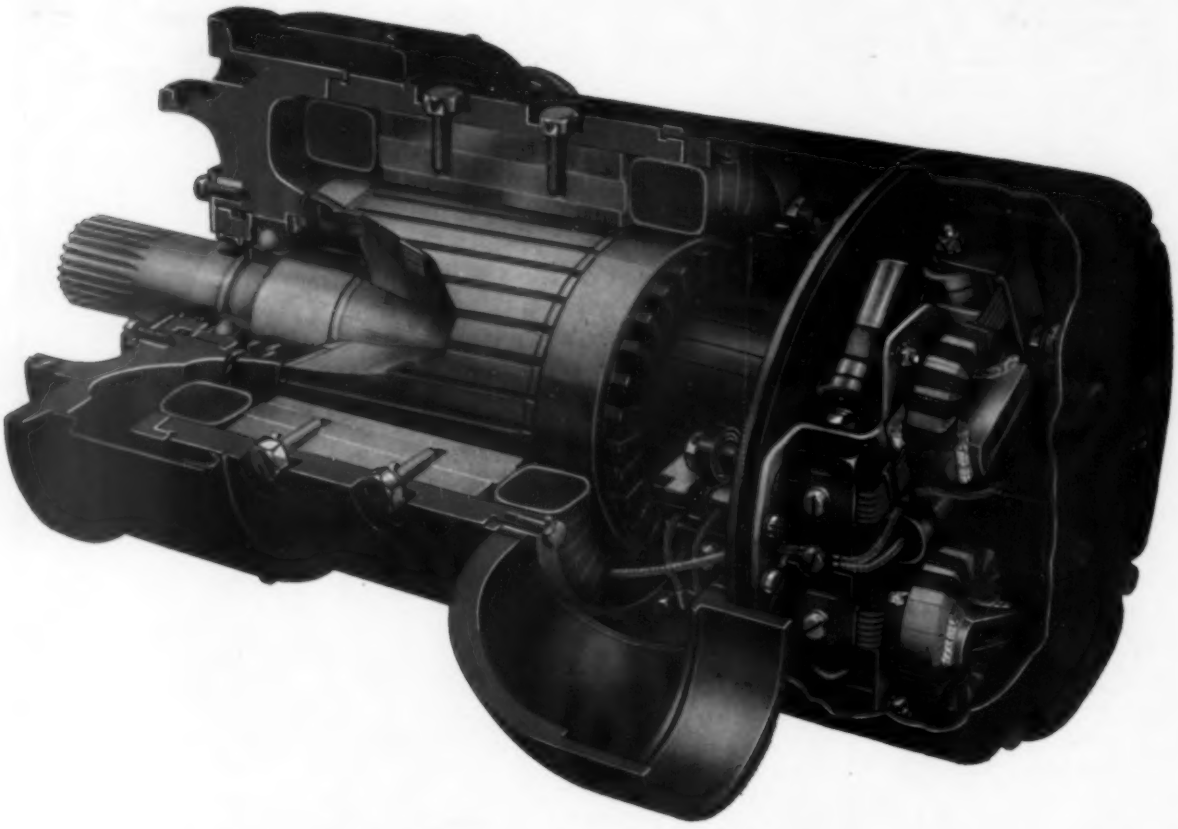

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CARRIER BASED: Two Bristol Sycamores make a pleasant picture in company with H.M.A.S. "Vengeance." In service with the Royal Australian Navy since January 1953, they have done useful work that has included flood rescue ("Vengeance's" three Sycamores, with shore-based helicopters, saved 70 lives in the New South Wales disaster).

HERE AND THERE

Otters for India?

INDIA'S Defence Ministry is reported to be considering the purchase of several D.H.C. Otters for the use of the Indian Air Force. An aircraft of this type has been flown to India for demonstrations.

Ordnance Board Appointment

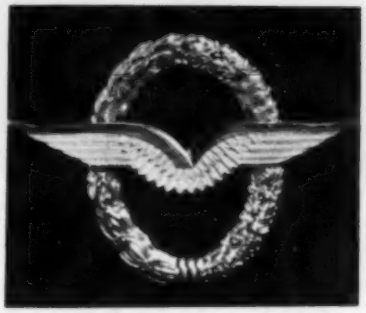
THE Ministry of Supply has announced the appointment of A.V-M. J. Marson as president of the Ordnance Board, in succession to Rear-Admiral S. A. Pears, R.N.(Ret.).

Sark Helicopter

A HELICOPTER was due to land on Sark last Monday—the first form of mechanized transport ever to be allowed there. Operated by an Irishman, Mr. Ivon Donnelly, and his partner, the Hon. Luke White, it may be used to fly perishable foodstuffs from Guernsey during the holiday season.

Vertols for Algeria

RECENTLY the French government announced that 100 helicopters would be "immediately purchased" for operations against the rebels in Algeria. It is now known that "a large number" of these will be 20-seat, tandem-rotor machines of the same design as the well-known H-21C Work-Horse, made by the Vertol Company of Morton, Pennsylvania. This company is the former Piasecki firm, from which Frank Piasecki recently broke away to form his own organization.



SILVER WINGS on a gilt garland will be worn by pilots of certain ranks in the new West German Air Force.

Navigation Litigation

A FEDERAL court in Washington has awarded a British firm a $1,375,211 (£491,150) judgment against Bendix Aviation Corporation concerning use of patents for aircraft navigation sextants during the last war. The award went to Smiths Merica Corporation, a local subsidiary of the owners of the patent, S. Smith and Sons, Ltd. The judge ruled that the British firm had a proper claim to collect on royalties due for use of the patents by the American company between 1943 and 1945. Counsel for Bendix had argued that they were entitled to use the patents without royalty under a war-time agreement between the British and U.S. governments.

Manpower Up Again

FIGURES issued recently show that, during December 1955, employment in the Aircraft industry stood at 248,400, an increase of 9,400 over the total for December 1954. This is the second highest figure recorded since the war, the November 1955 total being the highest at 249,000.

Towards Standardization

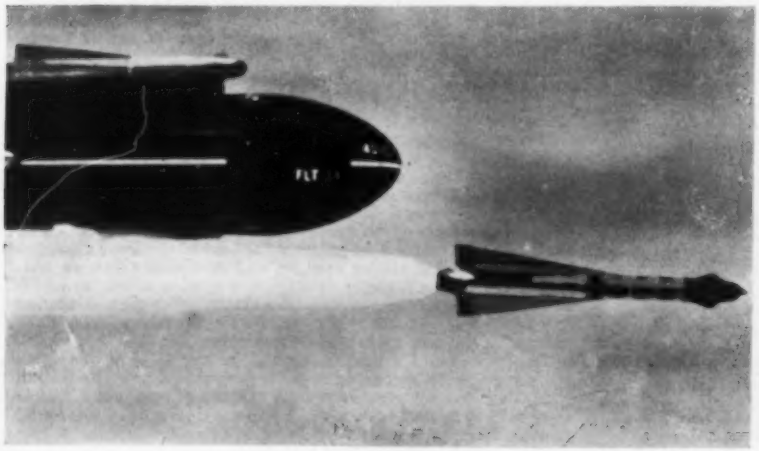
WASHINGTON RADIO reported recently that Britain and the U.S.A. have tentatively agreed on common standards for jet engines, following a series of meetings in Washington between representatives of the Civil Aeronautics Administration and the Ministry of Supply, the Air Registration Board, the U.S. Civil Aeronautics Board, and other interested bodies.

Welding and the Commonwealth

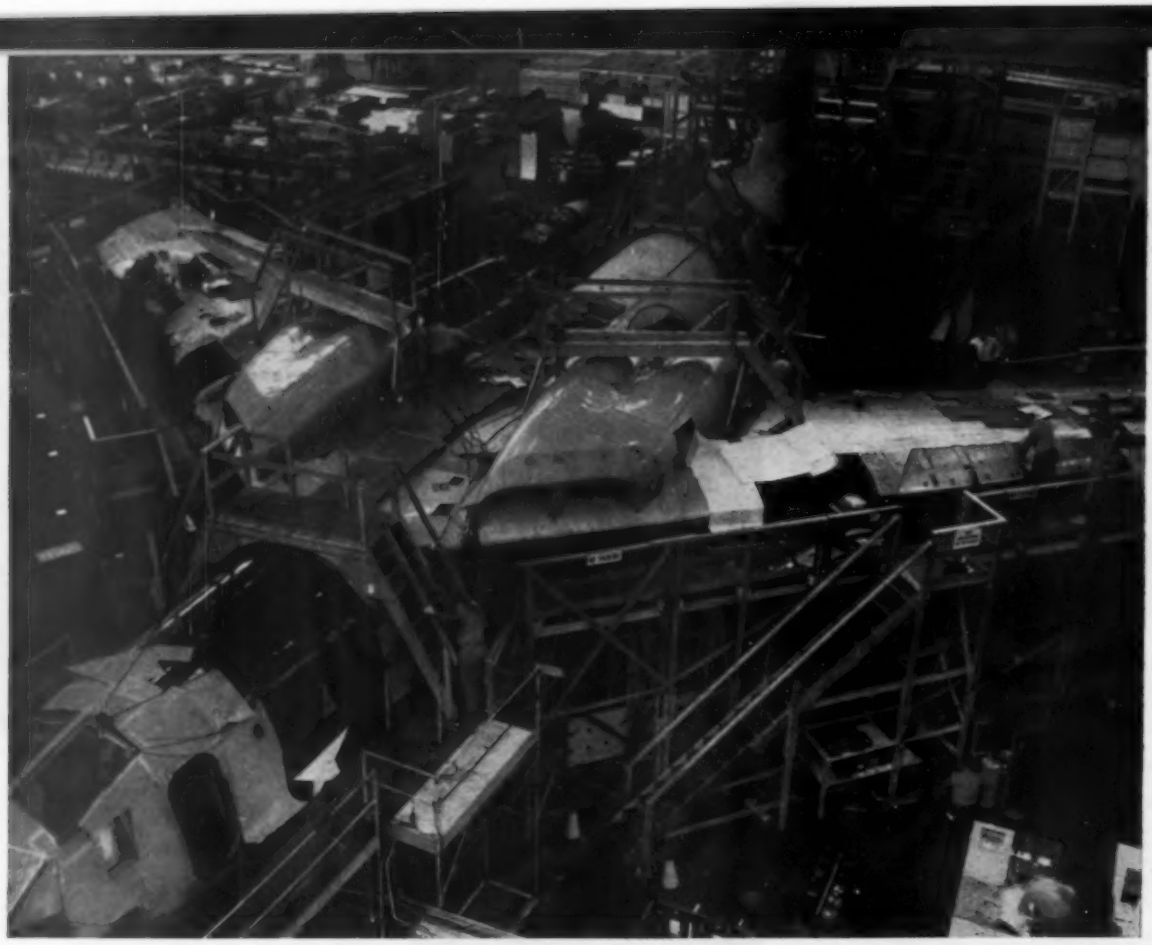
IT is hoped that there will be considerable support from overseas for the first British Commonwealth Welding Conference, which is to be held in London and at Saltburn-by-Sea, Yorks, from June 17th-19th, 1957. Details are obtainable from the organizers, the Institute of Welding (C.W.C.), 2 Buckingham Palace Gardens, London, S.W.1.

Fatigue Conference

AN international conference on the fatigue of metals is to be held in London from September 10th to 14th. The sponsors are the Institution of Mechanical Engineers, with the American Society of Mechanical Engineers co-operating, and a follow-up meeting will be held in the United States in November as part of the A.S.M.E. annual meeting.



STING WITH BRAINS: Northrop's F-89H Scorpion is the first aircraft to go into service armed with active-homing missiles. Each of its wing-tip pods now bears rails for three Hughes GAR-98 Falcon weapons, in addition to spin-stabilized rockets stowed inside.



The prototype XP6M in the final assembly stage at Baltimore. A pair of Allison J71 turbojets are visible in the background.

Producing the First SeaMaster

By ADOLPH VLCEK, JR.*

THIS article is one of the first to describe details of the construction of a large high-speed prototype. The Martin P6M SeaMaster embodies numerous unusual features, some of which are structural (and are dealt with here) while others are of a military nature, such as the rotating weapons-bay door upon which can be mounted various stores or a camera pod. The Glenn Martin company of Baltimore unfortunately lost the first prototype late last year when it had completed only a little more than 50 hours' flying. As a result, the special military equipment fitted in the second prototype has had to be removed and replaced by experimental equipment to continue flight tests. Nevertheless, the programme has not been seriously delayed, and the U.S. Navy expect to use many P6Ms for all kinds of military purposes involving new techniques, such as refuelling from submarines. Production P6Ms will be powered by four Pratt and Whitney J75 turbojets, and it is expected that one airframe may be used for experiments in nuclear power.

IN keeping with the many innovations in the XP6M Martin SeaMaster design, the manufacturing plan for the prototype introduced new concepts in experimental aircraft production. First, design requirements for volume producibility were made an integral part of the original experimental designs. Second, the job was scheduled through regular production channels, using standard procedures and regular production workers and machines. Third, during construction the ruling principle was "do it with what we have"—no new machines or equipment were purchased except one or two items which could not be improvised. The result was a calculated saving of 25 per cent over the usual experimental construction methods and this, on a multi-million dollar contract, was a worthwhile saving.

Producibility Planning. Chief feature of the producibility planning is the assembly break-down which, taking advantage of the small cross-sectional area of the hull, makes it possible to assemble the hull in sectional fixtures like a landplane instead of the giant hull docks required for most seaplanes. The first model was built in a one-piece hull dock but the production models will be assembled in movable sectional fixtures without delay due to redesign. Another producibility feature is the extensive use of forgings and castings in the airframe structure. Normally fittings on large experimental ships are hogged and milled out of bar stock, but, since the SeaMaster was designed for production from its inception, castings and forgings were specified frequently. Martin's own production foundry aided considerably in carrying out this policy, since it is equipped to make one or two parts of a given design at low cost. Producing a ship loaded with advanced design features without buying a great deal of new equipment required unusual ingenuity and improvisation.

Thick Wing Skins. The thick, tapered wing skins represented a distinct departure from conventional design and required development of several special processes. For example, rivet holes had to be drilled normal to the contoured surface. This required an ingenious bridge-type drilling and riveting fixture which was about 100ft long by 15ft high [illustrated on p. 352—Ed.].

Navy specifications required the skins to be drilled and trimmed before anodizing, which added about 30 per cent more surface to the already huge surface of the skins and called for unusual anodizing facilities. An old, unused anodizing tank was enlarged to take the 40-ft skins. It was moved close to an installed generator of sufficient capacity to provide the power requirements. The floor had to be shored up to carry the load of the large tank, the great volume of anodizing solution, and the 800-lb skins. Experimental tests were made to develop new process schedules which would produce the unusual conditions required by the engineering specifications. Finally, the anodizing operation was done successfully at a cost far below expectations.

Development of a sealing method for the integral wing fuel tanks required an extensive research programme in which several methods of sealing were tested. A method of applying a double thick fillet of EC 801 sealant to the joints and rivet holes was found to meet the requirements.

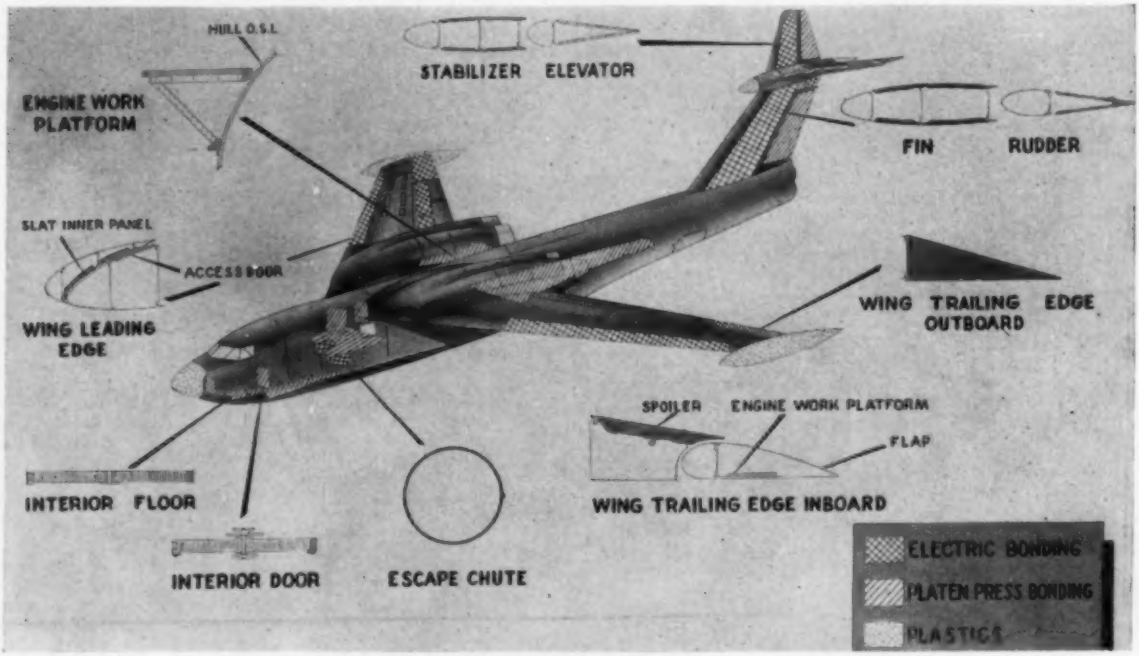
*Tooling Manager, Glenn L. Martin Co., Baltimore, Maryland.

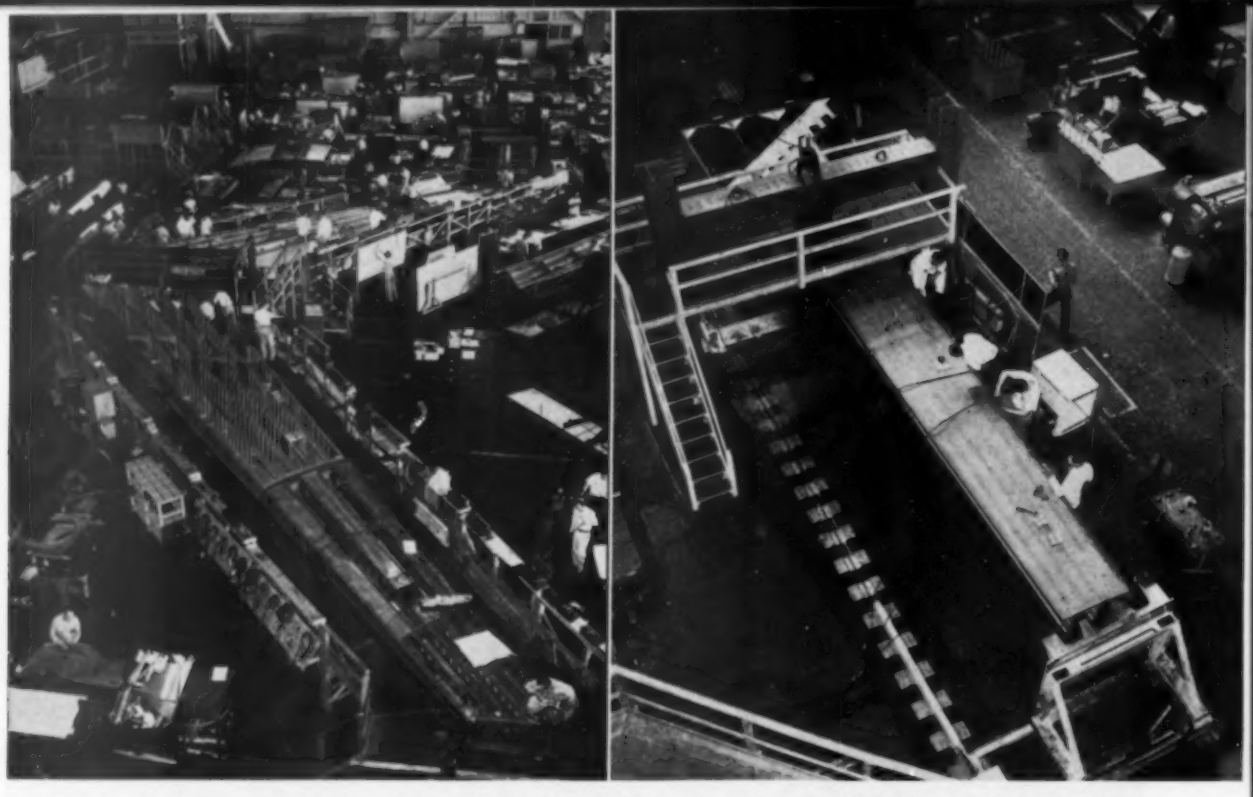
The prototype hull moving into the final-assembly position. The wings were joined to the hull stubs while remaining in their holding fixtures.

Wing-splice Flanges. The wing is spliced to the stub, which extends through the hull, by conventional bolted fittings at the spars, plus a tongue-and-groove bolted joint in the thick wing skins. To maintain the high accuracy required in assembling the wing root structure and machining the close tolerances required in this skin joint, a root end-gauge was made with the aerofoil contours machined by a special contour-milling attachment mounted on a planer. This device consisted of a bracket clamped to the travelling head of the planer and a hinged arm with a motor-driven milling cutter and a follower cam. The cam rode on a loft template guiding the cutter to the wing profile.

Another portable miller was developed to cut the precision surfaces of the tongue-and-groove skin joint after the wings and stubs were ready to be joined. The machine was mounted on a track attached to the end-gauge and had a cam which followed the contour previously cut. Changing the cams permitted cutting

An analysis of the extent to which Martin employed honeycomb (Marbond) metal sandwich and plastic assemblies in the SeaMaster design.





Prototype wings (left) were assembled in simple horizontal fixtures in which the heavy skins and spars were laid without complex locating devices. On the right is the bridge used for drilling and riveting the thick wing-skins with the required accuracy.

PRODUCING THE FIRST SEAMASTER...

fine-tolerance finishes on both top and bottom of the tongue and the groove. Both tongue and groove follow the contour of the skin, which is reinforced at the joint with doublers making it thick enough for the groove and strong enough to serve as a bolted joint.

Heavy Extruded Members. In keeping with the policy of utilizing volume production methods, extrusions were used for wing-chord members and hull longerons. Normally these would have been hogged and milled from bar stock, but it was found that extrusions could be used with relatively little milling (in the soft condition) to final shape. After heat treatment, the Martin-developed free-fall quench was used, eliminating much of the distortion caused by normal basket quenching. This was the first time the free-fall quench method was used with heavy sections, and results were as good as with thin sheet parts.

Nacelle Fairings. The nacelles of the P6M-1 SeaMaster's four J71 turbojets are joined in "Siamese" fashion. This configuration is difficult to tool, especially in the throat openings where there is a complexity of compound curvatures with inner and outer skins faired to aerodynamic contours. Subsequent nacelle fairing in the throat areas will be founded largely upon mean-flow characteristics established by the prototype nacelles.

Tools for the nacelles were the conventional plywood-header, plaster-filled master model, sometimes referred to as a Skin Dummy. The inner and outer skins were both Yoder-hammered to suit the contours of master models; they were made in separate pieces and joined at the leading edge of the nacelle throat.

Forming Sheet Titanium. Extensive use of sheet titanium in the SeaMaster, at a time when data on forming titanium were virtually non-existent, required a comprehensive research programme to determine optimum temperature and pressure requirements. These data were developed for brakes, Marform and rubber-blanket presses, and stretch presses. As a result, the first SeaMaster contains more than 500 titanium details, the largest of which is a formed sheet bulkhead 30 by 45 inches.

Welding Titanium. A quick survey of all aircraft plants for advice on how to weld these titanium details once they were formed, revealed that no one had a production process. Work consequently began to find a welding process which would avoid the metal's well-known susceptibility to contamination. A successful process for use in open-air conditions was developed and Martin became the first aircraft manufacturer to train certificated welders for commercially-pure titanium.

Marbond on the SeaMaster. Martin's pioneering work in adhesive bonding proved a valuable asset when the SeaMaster design called for bonded honeycomb structures of sizes, types and configurations far beyond normal bonding requirements. The honeycomb sandwich blankets for the fin and tailplane called for a pan-type sheet-metal inner skin, to which the honeycomb core was laid and bonded. When the outer skin was laid on, preparatory to bonding, difficulties arose when it was found that the inner skin could not be formed accurately enough to ensure a consistent glue-line and a perfect bond without using excessively expensive forming methods. The solution came with the development of a method of machining the honeycomb core to the exact height of the flanges on the pan after it was bonded in the pan-type inner skin. A special mushroom-shaped milling tool was developed for this operation and is still being used to cut recesses for doublers and inserts in honeycomb core. However, Martin's latest method of levelling honeycomb core uses a band-saw instead of the milling cutter. [Martin pioneered much of this work with the TM-61 pilotless bomber—Ed.]

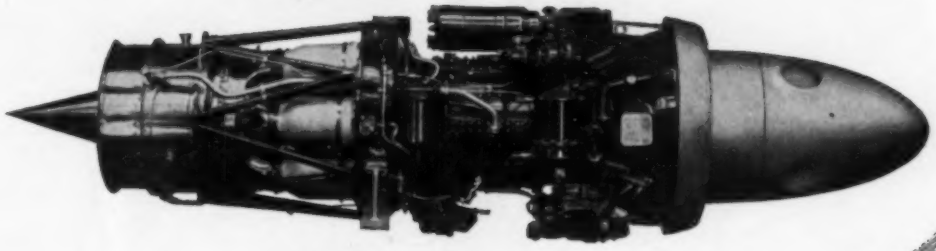
Plastics and Plastic Tooling. Plastics were used on the first SeaMaster for radomes, wingtip floats, tailplane tips and many other components. In addition, plastic tooling was used extensively for forming both plastic and sheet-metal parts. Martin-developed cast phenolic male moulds were used to form the nose cone, tailplane tips and, in a Guerin-type press, for forming the beaded sheet-metal wing leading-edge skins. Glass-fabric epoxy-resin laminations were used for drill fixtures, trim templates, and check templates. The largest plastic template was used for trimming the wing-root skins.

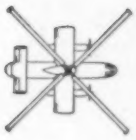
A laminated epoxy-resin bell-mouth was built for use on the test stand for the dual engine nacelles. This giant was 10 ft long, 7 ft wide and 5 ft high and was attached to the nacelle mounting located in a noise-suppression chamber. Only one was needed and it would have been prohibitive in metal. Moulding it with plastic provided a smooth finish and accurate contours without elaborate tooling. It was formed over a collapsible mould made of inexpensive plaster, wire-mesh, cloth, sheet-metal and plywood. A surface coating of epoxy was applied to the mould and lay-ups of glass fabric and resin formed the main surfaces of the bell-mouth. Reinforcements were Masonite ribs cemented to the laminated structure. Using ordinary hand tools, the air-flow surfaces were dressed and buffed to a fine finish to minimize turbulence and high-speed air noises. With both engines running the flow of air is approximately 360 lb/sec.

"Hush House". The engine test stand was mounted in a "Hush House" or engine noise-suppression chamber. This building and its noise suppression devices were designed and built to test SeaMaster engines to be used on production models [Production machines will be powered by the much larger Pratt and Whitney J75—Ed.] as well as on the prototype.

The building, which is a resonant chamber, and the 46-ft mufflers extending behind it, bring the engine noises down from about 175 decibels at the afterburner nozzles to only 110 db immediately outside the building and 78 db at a distance of 150 ft.

3 engines of increasing importance





ELAND A Convair 340 aircraft converted to Eland engines will be on demonstration flights in Europe and the U.S. during this year. Another aircraft powered by *Elands* is the Elizabethan, converted for freighter evaluation. Napier *Elands*, fitted with auxiliary compressors for the tip-powered rotor system, will be mounted in Fairey's new large transport helicopter, the Rotodyne.

ORYX Two Napier *Oryx* engines are being mounted in the new Percival P74. Napier worked with Hunting Percival in the development of the *Oryx*, a 750-825 gas h.p. turbo-gas-generator which has been Type Tested at 780 g.h.p. This new Napier power unit eliminates all mechanical transmission.

GAZELLE The *Gazelle* is another Napier engine which is going places. Two *Gazelles* will be mounted vertically in the new Bristol twin rotor helicopter, whilst other designs to be powered by this engine are well advanced. The engines are directly connected to the rotor heads, providing mechanical transmission in its simplest form.

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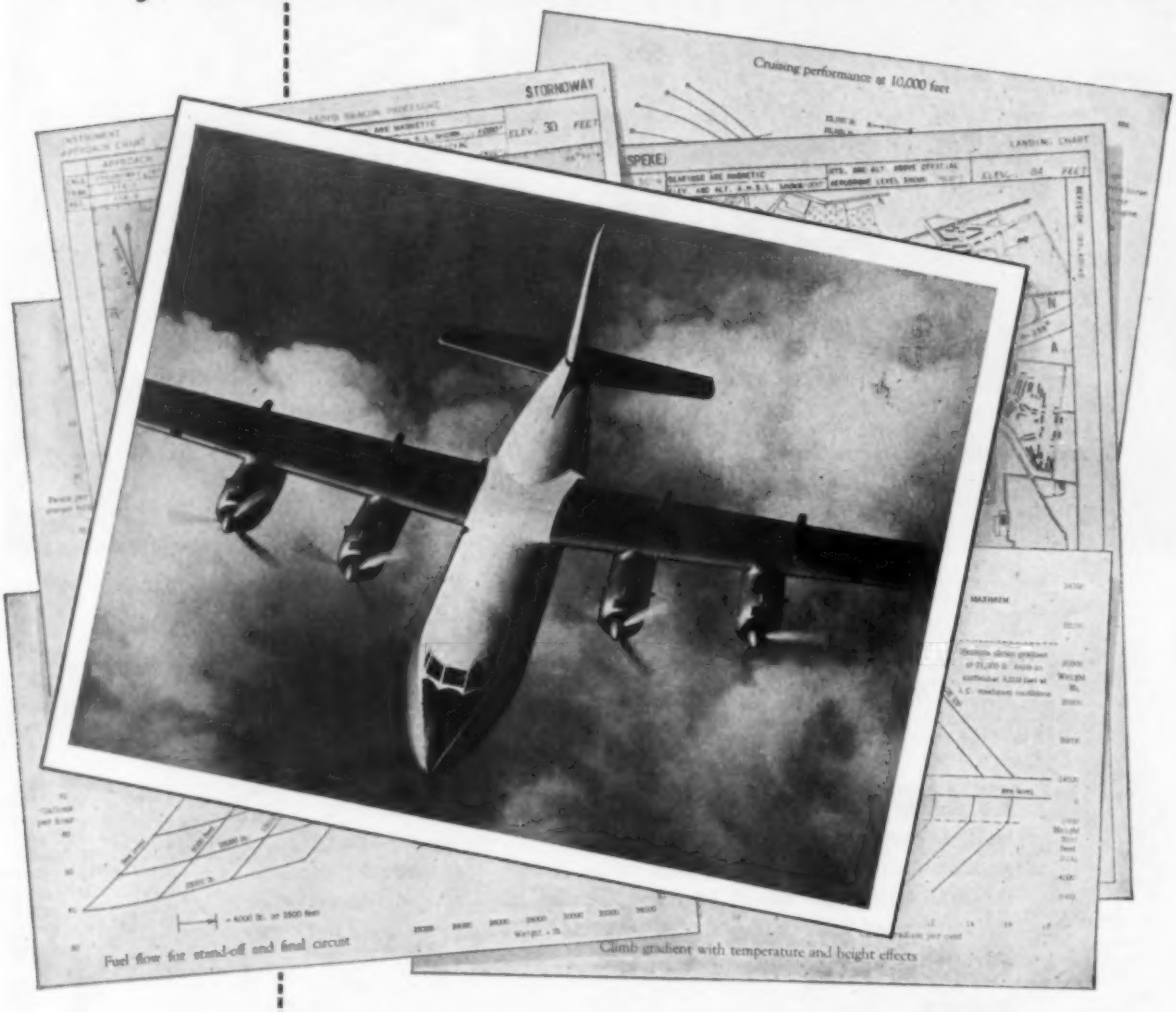
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PROVING the BRITANNIA

By CAPTAIN A. S. M. RENDALL, B.Sc

Flight Superintendent, B.O.A.C. Britannia Fleet

Captain Rendall, who since 1953 has been closely concerned with the operational development of the Bristol Britannia, recounts his personal impressions.

During the tropical trials in Johannesburg somebody said, "If I understand you correctly, the Britannia is a very orthodox aeroplane except that the controls are not attached to the control surfaces and the propellers are not attached to the engines."

BRITISH Overseas Airways Corporation has been associated technically with the Bristol Britannia from the outset, when the project was conceived as an aircraft with four Centaurus piston engines and an all-up weight of 114,000 lb; but it was only just over two years ago that a nucleus of operational personnel was formed to participate in the development. Starting in October 1953 with two pilots and the fleet manager designate, this nucleus grew until by the summer of 1955 it comprised 17 pilots, five engineer officers, four radio officers and two navigation officers. Throughout this period there has been very close co-operation and exchange of views between B.O.A.C. and Bristol.

For the first year there was no solo flying for B.O.A.C. pilots, but there was much to be learnt and many operational aspects to be discussed. Towards the end of 1954 a programme was arranged for Britannia aircraft to accumulate 2,000 flying hours before C. of A. application; of this, 1,000 hours was to be done on G-ALBO (the prototype) and the remainder on G-ANBA and G-ANBB. This flying programme could not have been carried out in the time planned by Bristol test pilots alone. Early in 1955, therefore, B.O.A.C. were asked to take over the flying on G-ALBO completely; thus, during the first half of last year, B.O.A.C. crews, most of whom will be flying instructors for the Britannia Fleet, flew some 600 aircraft hours on this machine.

Later came a further programme for 250 hours of route-proving flying. For these flights, not only was the aircraft to be operated through the climates and conditions it will meet in service, but also the laid-down maintenance schedules were to be followed and representative turn-round times adhered to. An ambitious programme of eight flights, to East Africa, Johannesburg, Bombay, Lod, Tripoli and Rome, was planned; and, in the event, the flights were completed in 41 days, at an average aircraft utilization of just under six hours a day. Again B.O.A.C. crews were asked to do this flying and, by putting double crews on each flight, the best use was made of the flying from a training point of view, and this also helped to keep the aircraft on the move. The "passengers," who usually numbered some 45, were technical observers and maintenance staff, except on the flights to Tripoli and Rome, when it was required to fill the aircraft to capacity. Then the 98 souls on board included a number of employees of Bristol and B.O.A.C. who had no more-onerous duties than to fill in a "comments card." A full B.O.A.C. cabin staff took good care of all on board; and many hardened observers, accustomed to cabins furnished with recording cameras and water ballast tanks, received the full luxury airline treatment for the first time. Incidentally, one could not but admire the composed manner in which the stewards unblushingly briefed the designers and manufacturers on the amenities and emergency equipment of their own aircraft. No less did one admire the stewardess who could make a technical observer sit down and fasten his seat belt for take-off.

B.O.A.C. personnel also participated in the overseas trials in G-ALBO at Tripoli in October 1954 and in G-ANBA at Johannesburg and Khartoum in March 1955, as well as on numerous other flights around Filton during the last two years. The eight Britannias that have flown so far had, by the end of February, 1956, accumu'ated a total of 3,300 hours in the air, of which 1,400 have been flown by B.O.A.C. crews.

What, then, do B.O.A.C. pilots think of the aircraft?

The control system referred to in my opening paragraph is unusual. All the control surfaces are operated entirely by servo tabs and the weight and complexity of systems which depend on brute force are avoided. The pilot's controls would be over-light if no artificial feel were fed into them; in the case of the rudder and ailerons this is done by means of spring pots, but in the elevator system the "Q" pot makes the weight of the control dependent on airspeed in a realistic manner. The rate of response to aileron deflection was considered at one time to be inadequate, and was in consequence improved, but one of the interesting facts that came out of the comparative tests conducted on another aircraft of similar size was the docility of the rolling tendency of the Britannia when an outboard engine was failed and no corrective action was taken. The effectiveness of the controls in severe turbulence was clearly demonstrated when, on a flight in search of ice, the aircraft was flown for a couple of hours through a series of thunderstorms around Lake Victoria, search radar being used to guide the Britannia into the centre of each storm. Attempts have been made to stall the aircraft during take-off by holding the "pole" fully back throughout the run; even with deliberate engine failure, no handling difficulties were encountered and the only effect was to decrease the distance-to-50ft by 20 to 30 per cent. Some fear was felt that ice-accretion on the elevator horn balances might seriously affect control, but it was recently demonstrated that 5½in of ice made not a ha'p'orth of difference at speeds from 180 kt down to the stall [see photograph overleaf—Ed.].

The behaviour of the aircraft on instrument approaches is very good, provided the rudder pedals are regarded merely as foot rests and the ailerons alone are used for following the localizer; any tendency to "harmonium feet" must be strongly suppressed. The elevators were at one time rather too light when flaring out for the landing and there was a tendency to "balloon"; this has been rectified most effectively by the fitting of a bias spring on the main elevator surfaces.

The pre-stall buffet is sometimes very close to the stall, so a stall-warning device in the form of a stick-shaker is fitted; this gives a very obvious warning at a minimum of 5 kt above the stall. As the main aileron surfaces are in no way connected together, both ailerons would tend to float upwards as the stall is approached, so a spring arrangement similar to that on the elevators is incorporated; this ensures lateral control down to the stall in all power-off configurations.

There can be few aircraft which, if stalled with a lot of power on, behave with complete gentility, and with persistence and a certain rugged determination the Britannia can be made to drop a wing fairly smartly under these conditions. With power off, the behaviour is very docile; a little buffeting, a controllable wing-drop, a gentle pitching and you're all set to do it again.

So much for the controls. My other opening reference was to the well known free-turbine arrangement of the Bristol Proteus engine, designed to give economy, flexibility of operation, ease of starting, and so on.

The Proteus has a long history of development behind it and is giving every indication of coming up to the high standard of reli-

The author of this article.

PROVING THE BRITANNIA . . .

ability that the Rolls-Royce Dart has foreshadowed for propeller-turbine engines. During the 250 hours of route-proving flying there was one engine failure, but this was due entirely to completely unorthodox use of the engine during test work; apart from this incident there was literally no other engine trouble whatever. The reduction gears were modified from spur to double-helical tooth-form some 18 months ago, and the new gears have now given 10,000 trouble-free engine-hours in flight.

The monotonous ease with which these engines will start up or relight in hot weather or cold, at sea level or at altitude, breeds confidence; but the most impressive feature, at least to a pilot new to turbines, is the power available at "continuous" rating. The old idea of a "maximum diving speed" is, of course, defunct for turbine-powered aircraft. The Britannia can, in fact, exceed its V_{no} ("never-exceed speed") in level flight with cruising power at altitudes up to 11,000ft; similarly, on *any two* engines, it can reach its maximum operating speed of 234 knots i.a.s. at approximately 3,000ft.

Because of this power the three-engined and four-engined procedures for approach, overshoot and landing are practically identical except that on four engines it is inconvenient to use full power for an overshoot. In practice this has the advantage that trainees can progress straight to three-engined practice without spending much, if any, time on four-engined approaches.

Because an operator does not want to go to the expense of laying down spare engines at numerous overseas stations, the three-engined ferry performance of a civil aircraft is of vital importance. The Britannia can, as an example, take off on three engines from Khartoum (1,250ft elevation) in the morning during the hot weather and fly to Entebbe, carrying normal diversionary and reserve fuel. If, during take-off, a second engine should fail and the undercarriage remain down, it would be possible for the aircraft to climb to 1,500ft above the aerodrome level, do a circuit, and land again.

If the electrical system of the Britannia appears complex at first sight, the operation of it is not. Following modern practice the generation is A.C. from four engine-driven alternators [in the Britannia 100.—Ed.], the total output of 130 kVA being enough, in layman's language, to supply three miles of sodium street-lighting or 50 houses. The failure of one alternator still leaves enough supply available for all electrical services. The failure of two alternators does not affect the technical operation of the aircraft, except for the loss of a small amount of the tail de-icing system. If, by great misfortune, only one alternator should be left economies have to be effected, but all services essential to the safe operation of the aircraft can be maintained.

As the alternators are not of the self-exciting variety, an emergency battery is maintained to re-excite them in the unlikely event of a serious earth on a busbar. One of the more-pleasing demonstrations is to isolate all batteries and switch off all alternators, and fly around for a while with no electrics on the aircraft at all, subsequently restoring generation by means of the emergency battery. The operation of the electrics is made simple by the diagrammatical layout of the control panels and by the use of transfer switches in the event of failure of alternators or inverters. These switches transfer or shed load in a manner appropriate to the failure, and magnetic indicators on the panel clearly indicate which circuits have been made and which broken.

A word might be said about the bogie undercarriage of the Britannia. It must be admitted that a bogie doubles the number of bumps on a bad runway, and (naming no names) there are quite a few of the latter in the eastern hemisphere. But this is a small price to pay for the safety that multiple wheels provide, the braking effect that can be achieved with eight wheels all fitted with Maxaret non-skid units, and the low runway loading factor so necessary in aircraft that only encounter acres of perfect concrete once on each round trip. The load concentration for the Britannia is, in fact, lower than that for either the Stratocruiser or the Super Constellation—and, of course, considerably lower than that for the DC-7C.

The fuel system is simplicity itself; four tanks supply the four engines and, for flights where no more than ten hours' fuel is carried, the operating drill is to switch on the pumps and cocks at the beginning of the flight and switch them off at the end. Where more fuel than this is carried a certain amount of cross-feeding has to be carried out.

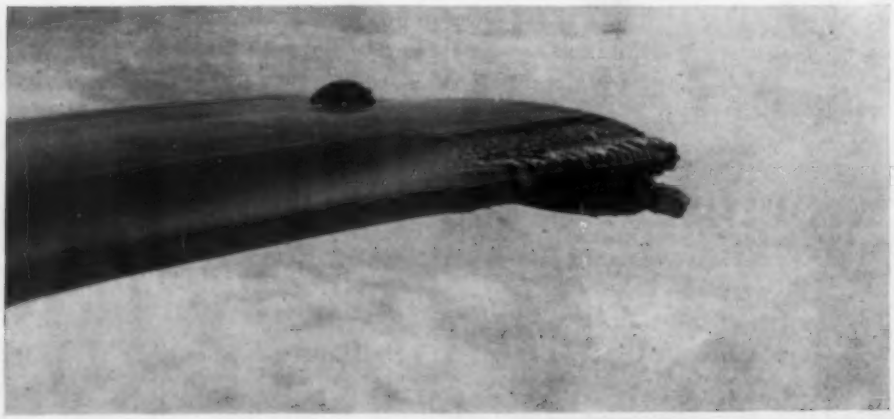
There are various philosophies behind the arrangements employed on different aircraft of controls to deal with an engine fire. On the Britannia the essential controls for each engine are in a row, in the correct order, on a roof panel accessible to both pilots. When the fire bell rings, a red warning light appears in the feathering button and another, at the bottom of the row of fire switches, clearly indicates the appropriate H.P. cock, L.P. cock, oil cock, fire-door switch and first- and second-shot fire extinguishers. Incidentally, the feathering takes only two seconds.

Taken all round, the Britannia will be operating to higher performance standards for take-off and landing than any other civil aircraft with a British Flight Manual and, what is more, it can operate at its maximum all-up weight at hotter and higher aerodromes. As an example, we shall be able to use the maximum a.u.w. out of Johannesburg except during the very hottest hours of the summer days. A most impressive piece of performance was an accelerate/stop carried out on the main 10,000ft runway at Jan Smuts at an a.u.w. of 150,000 lb; the aircraft was accelerated to 120 kt and then the H.P. cock on No. 4 engine was closed; the other three engines were then put into reverse and full wheel-brakes applied. When the aircraft came to rest there was still half a mile of runway left.

There have been many high-lights like this in the last two years of association with the Britannia; one in particular that comes to mind was the 10 hr 50 min direct flight from Khartoum to Filton, 2,730 nautical miles, against an average headwind component of 60 kt all the way. There is one feature, however, that has won the hearts of all her pilots in no uncertain manner—and that is the search radar. There have been many improvements in aircraft and in associated facilities over the years—such as feathering airscrews, high-lift flaps, instrument landing systems and approach-lighting and two-mile runways, but all these things have barely kept pace with the increased size, wing loading and approach speeds of present-day aircraft. Judged by weather minima (coupled landings apart) the pilot has gained nothing and we are back to where we were 20 years ago when aircraft came in at 65 m.p.h. on "series QDMs".

In search radar the pilot really gets something, all for himself, with no strings attached. Its secondary use for map painting is a great comfort when beacons are scarce (Nairobi to Johannesburg) or when the A.D.F. is pointing to the nearest thunderstorm, and on some sections of a route, such as from Dijon to Caraffa, it gives a continuous indication of position. It is on a filthy black night, however, with solid medium cloud and embedded cumulo-nimbus, that it becomes the pilot's best friend. As each fresh horror comes up on the tube he makes a small adjustment to the autopilot, takes another sip of coffee and thinks what hell it must be for the people on the ground. Surely, as a colleague remarked, the greatest thing for stomach acid since bicarbonate of soda.

Editorial footnote: The following are the manufacturers of some of the items mentioned by Capt. Rendall. Airframe—Bristol Aircraft (assisted by Short and Blackburn); engines—Bristol Aero-Engines; airscrews—de Havilland Propellers; undercarriage—British Messier; brakes and "Maxaret"—Dunlop; search radar—Ekco; de-icing—Bristol and Napier.



How not to conduct an airliner—but how nice to know how safe: A take-off with the "pole" held fully back from the start of the run. (Picture from a ciné record.) (Below) 5¼ inches of ice on the elevator horn balance made no difference to the Britannia's controls, from 180 knots down to the stall.

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F

THE GIPSY MAJOR 200

for

reliability, long life and outstanding fuel enonomy

The Gipsy Major 200, power-plant of the Saunders-Roe Skeeter 6, is approved for operation at full-throttle power (200 b.p.h.) for periods of one hour's duration.

DE HAVILLAND ENGINES

SAUNDERS-ROE SKEETER

Development and Construction of the Mark Six

THE entry of the Saunders-Roe company into the helicopter field was made in 1928, when the Helicogyre was built and tested at the company's works at Cowes. This machine, designed by V. Isaaco, had a distinctive configuration featuring a Bristol Cherub engine mounted at the tip of each of the four rotor-blades. It was later dismantled and shipped to the Royal Aircraft Establishment, Farnborough, where it was re-assembled and tested in the Balloon Shed.

This article is concerned, however, with the Mk. 6 Skeeter, powered by the Gipsy Major 201, and its military versions—latest in the Skeeter line and (although not originally a Saunders-Roe design) virtual descendant of the Helicogyre. A brief summary of the development of the Skeeter from the initial design makes an appropriate introduction to our description of this latest version of the machine.

The original Skeeter Mk. 1 was designed by the Cierva company at Eastleigh and, powered by a 106 h.p. Jameson engine, made its first flight on October 8th, 1948. Compared with the Skeeter as it is now known, this machine was smaller, lighter and of somewhat different appearance. The Mk. 2, incorporating an amount of re-design and fitted with the 145 h.p. D.H. Gipsy Major 10, made its first flight just over one year later, on October 20th, 1949. This version did not reach the anticipated performance, and was followed by the improved Mk. 3, similarly powered.

In January 1951 Saunders-Roe took over the facilities and work of the Cierva company at Eastleigh, and formed a Helicopter Division with Mr. M. J. Brennan responsible for helicopter design. The conversion of the Skeeter Mk. 3 into the Mk. 3B, powered by a 180 h.p. Blackburn Bombardier 702, was the next step in its development. Built under M.o.S. contract, the 3B was intended for Army use; a Naval version, the Mk. 4, was constructed in parallel and was also Bombardier-powered.

Mr. T. L. Ciastula, now in charge of the design team of the Saunders-Roe Helicopter Division under Mr. Hugh Gordon (general manager), has described the subsequent Skeeter progress as follows:—

"In March 1953, the Skeeter Mk. 3B was sent to A. and A.E.E. for trials, and in the following month the major obstacle to its development became apparent. The aircraft, under certain operating conditions, proved to be subject to 'ground resonance,' and this characteristic had to be eliminated before any further progress could be made. . . .

"The line of attack adopted for the elimination of ground resonance in the Skeeter was as follows:—

"(a) Impedance or 'shaking' tests were conducted to determine the natural frequencies and the equivalent dynamic stiffness and damping at the hub when it is excited by oscillating forces in the fore-and-aft and lateral directions.

"(b) The characteristics of the blade friction-dampers under oscillating conditions were determined on a specially constructed rig. Undercarriage damping was also measured.

"(c) A theoretical analysis was made to determine the instability ranges for the Skeeter, using the results obtained in the above tests.

"(d) The undercarriage and blade friction dampers were re-designed to give satisfactory damping to eliminate the instability.

"(e) In parallel with the above programme, full-scale ground-resonance tests were conducted in the company's helicopter ground-running compound, with specially designed snubbing arrangements to damp out vibrations of the helicopter when ground resonance was encountered. In these tests, the minima of undercarriage damping and blade damping were determined experimentally and actual ground-resonance was reproduced.

"(f) A Skeeter with re-designed undercarriage and blade dampers was subjected to final resonance tests in the compound and, finally, flown through all conditions that experience had shown to be conducive to ground resonance. . . .

"Finally, in March 1954, this aircraft (Skeeter Mk. 5 G-AMTZ) was sent to A. and A.E.E., Boscombe Down, for evaluation trials which confirmed that it is now free from ground resonance."

It should be mentioned that these investigations into the source of the ground-resonance problem, its solution, and the construction of the Mk. 5 civil version with the revised damping and snubbing arrangements, were carried out at private expense by the company, Ministry of Supply support having been withdrawn in 1953 when the ground-resonance difficulties persisted.

The latest version of the Skeeter is powered by the D.H. Gipsy Major 201 engine. In its civil form (G-AMTZ is at present being modified and re-engined in order to obtain a C. of A. for this version) it is known as the Skeeter Mk. 6. The military version of the Major 201 engine is known as the Major 130 and two military Skeeters, thus powered, are now flying. They are prototypes of the Mk. 10 and the Mk. 11 machines designed for the A.O.P. rôle and as an R.A.F. training helicopter respectively.

These two aircraft are owned by the Ministry of Supply, who

The D.H. Gipsy Major 201 (military version 130) is installed transversely in the Skeeter 6, and has been developed to produce its maximum power for periods of up to one hour. Cowlings are removable for flight, if desired.

Some stages of Skeeter development: (left to right) the Mk. 1 (Jameson), Mk. 2 (Gipsy Major 10) and Mk. 5 (Bombardier).

SAUNDERS-ROE SKEETER . . .

in May last year placed an order for three pre-production A.O.P. versions and one trainer. XJ 355 is being utilized for the type-testing of the engine installation and transmission, while XK 773 is fitted (as a trial installation) with the new form of dual left-hand collective-pitch levers and a re-designed instrument panel. From the statement in the House of Commons last month by the Minister of Supply that the Army would rely on the Skeeter as an A.O.P. helicopter, it appears that full production will follow.

Design and Construction.—The Skeeter was conceived as a light (two-seater) all-purpose helicopter, with the emphasis on suitability for training. From its size and engine-power, such a machine would necessarily give an operating economy better than the more powerful machines adapted from their designed functions to the training rôle. Necessary in addition were handling characteristics representative of other helicopters of comparable size, and the robustness, simplicity and reliability required by any training aircraft. In the design of the cabin, visibility considerations of the A.O.P. rôle were of primary importance.

The Skeeter 6 is an all-metal, two-seat single-rotor machine with a tail rotor for torque compensation and yaw control, and is powered by one D.H. Gipsy Major 201 (civil) or 130 (military) engine. The aircraft is constructed in three sections; the forward cabin structure, the central power-unit mounting and the rear fuselage. The engine is mounted transversely in a welded tubular-steel framework, at the forward end of which is bolted the cabin structure and at the rear end the tail cone supporting the tail rotor.

The geometry of the tubular framework of the centre section is shown in the sketch on page 357. The material is T.59 steel tube, typically one inch in diameter and of 20 s.w.g. The engine is carried on four feet, which are located in Metalastik bushes and bolted to mild-steel mounting brackets on the tubular framework.

As illustrated on page 357, the rotor drive is taken off the horizontal crankshaft on the starboard side. The primary gearbox, incorporating rotor-engaging and freewheel clutches, is mounted directly on the engine; from this gearbox the drive is transmitted by a short intermediate shaft to a secondary gearbox which is located at the base of the main rotor shaft. This gearbox comprises a crown wheel and two pinions, one of which transmits the input from the engine and the other the drive to the tail rotor. The tail-rotor transmission is by means of torque shafting running inside the tail cone, suitable gearing providing the required change of speed and direction. Fan cooling for the engine is provided through a starboard intake in the centre-section.

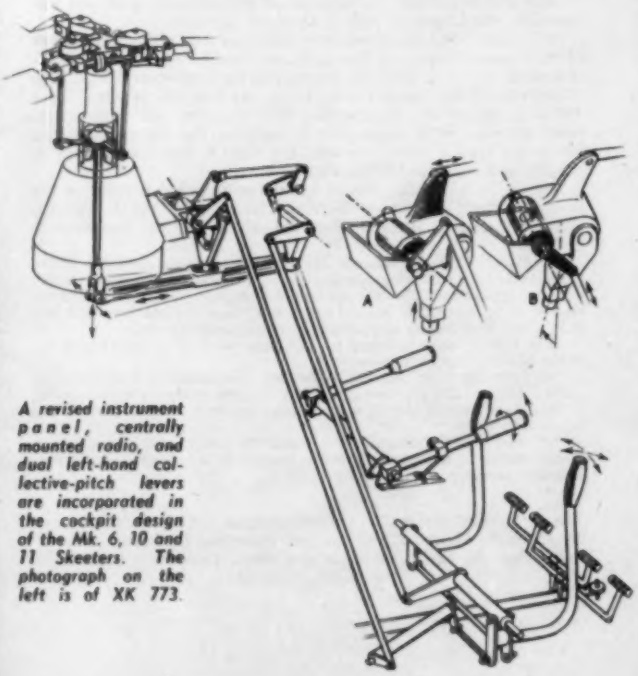
The three main rotor-blades are mounted on the hub at the top of the rotor shaft and are connected to it *via* the flapping hinges. A vertical hinge in the flapping link permits drag movement to take place; these hinges are fitted with variable-rate friction dampers in order to damp down blade movement in the drag plane. To restrain the relative blade spacing within prescribed limits, a snubber is fitted between each pair of blades at the root end.

The composite construction of the Skeeter's main rotor-blades has remained basically unchanged throughout the development of the machine, the main advantages of this method being simplicity, cheapness and good fatigue properties. Each blade incorporates a steel-tube spar, to which are bonded wood veneers, formers and ribs. The leading edges carry a line of brass balance-weights (bringing the c.g. to the 25 per cent position) glued to an ash l.e. member, with birch ply skinning. The trailing-edge member is of folded metal, with a spruce core, and the whole blade is fabric covered. Aerofoil section of the blade, which is untapered at 10in chord, is NACA 23017.

The Saunders-Roe helicopter division at Eastleigh is at present well advanced in developing a metal rotor-blade under M.o.S. contract. Although the long-term objective of this development work is of a general nature—to produce a metal blade of entirely new conception, both in design and in method of construction—it is a light-alloy blade for trials on the Skeeter that has been designed in the first instance. The aerodynamics of this blade will be superior to the present one, and a commensurate improvement in performance can be expected.

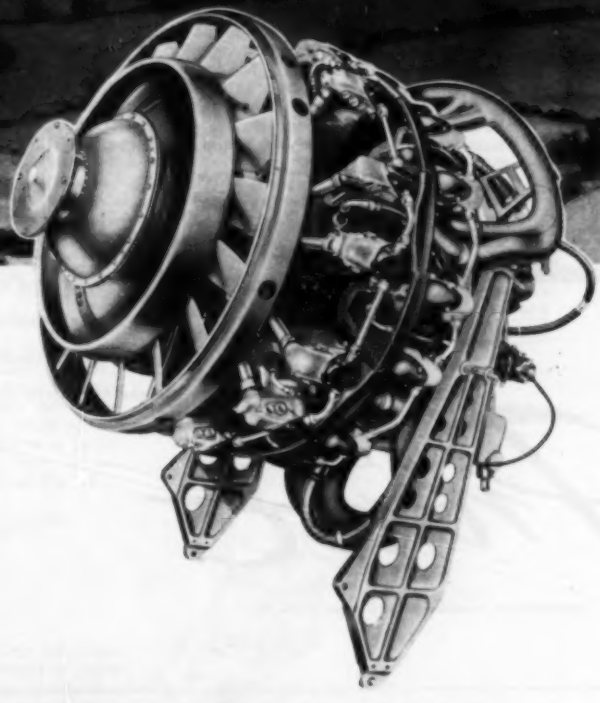
Fuel is carried in a 23-gal Hycar nylon-reinforced bag-type tank located behind the pilots' seats. It is fed from a booster pump in the tank to the main control cock on the control structure between the seats, and through a filter to a fuel pump on the engine. With the exceptions of flexible pipes to the engine and between the tank and the selector cock, rigid pipes are used throughout the fuel system.

The Major 201 employs inlet-port fuel injection in place of the conventional float-type carburation of earlier Gipsy engines. This refinement, in conjunction with an induction system of high



Main-rotor controls (right). Details A and B show Z-crank mechanism which ensures negligible interaction between collective-pitch and cyclic lateral controls. Collective-pitch lever movement (A) acts on top horn; mechanism rotates about bobbin axis; raises or lowers yoke, main control beam, vertical spindle, spider and drop-arms. Cyclic lateral motion (B) causes mechanism to rotate about skewed spindle; resulting "swashplate" action swings yoke to one side (angle exaggerated in sketch); motion transmitted via beam and vertical spindle to spider. Cyclic fore-and-aft linkage acts on extremity of main control beam in straightforward manner.

A revised instrument panel, centrally mounted radio, and dual left-hand collective-pitch levers are incorporated in the cockpit design of the Mk. 6, 10 and 11 Skeeters. The photograph on the left is of XK 773.



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ALVIS LIMITED COVENTRY ENGLAND

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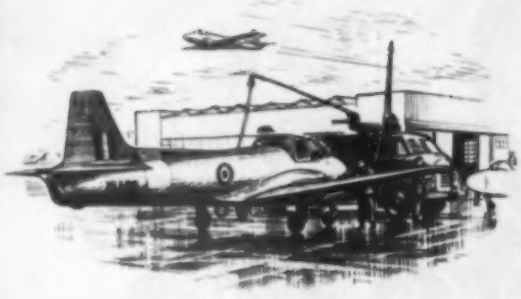

The ability to complete pilot training to "Wings" standard on the minimum number of aircraft types is an ideal at which all Air Forces aim. The JET PROVOST has demonstrated that with a maximum level speed of more than 280 knots, a ceiling of 35,000 ft., a retractable nosewheel undercarriage, air brakes and a turbo jet engine, it is ideally suited to ab initio training in addition to leading into the advanced trainer . . . so enabling the two-stage training ideal to be maintained for many years to come. Furthermore, the need for jet conversion training on the expensive Advanced Jet Trainer no longer arises.

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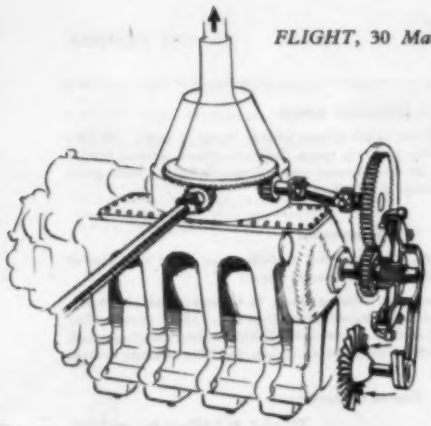
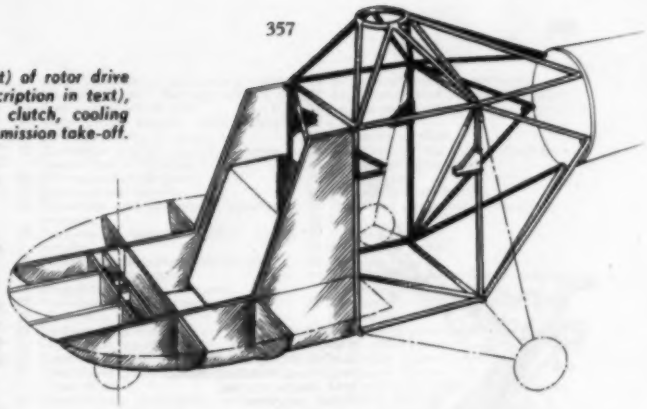


Simplified sketch (left) of rotor drive from engine (see description in text), including centrifugal clutch, cooling fan and tail-rotor transmission take-off.



Primary structural framework of the nose section and centre section, showing fuel tank, engine-mounting brackets and five-point attachment of rear fuselage section.

SAUNDERS-ROE SKEETER . . .

aerodynamic efficiency, is claimed to give an exceptional fuel economy throughout the operating range. Engine-starting is by means of a Plessey cartridge-starter located aft of the firewall on the port side.

The 24 s.w.g. light-alloy centre-section cowlings (with the exception of the lower port panel, at the engine exhaust-manifold position) are removable, and the machine may be flown with or without the cowlings in place. To improve the flow of cooling air when the engine is cowled, an increased area of Expamet expanded-metal mesh has been incorporated in the top panels.

The undercarriage, designed and built by Saunders-Roe, consists of two fixed main-wheel units (two pin-jointed oleo-spring shock-absorber struts with vee radius-rods), of 7ft track, and a castoring nosewheel unit which also has an oleo-spring shock-absorber. Wheels, tyres and brakes are by Palmer Tyre, the three wheels (Type 922B, 3½in dia. rim) being interchangeable, and fitted with high-pressure twin-contact tyres (size 4.00 × 3½in), of 11in outside diameter. Each wheel has a small pressed-in brake-drum which, on the main undercarriage only, is used to accommodate a small mechanically operated two-shoe expanding brake. The main undercarriage legs are attached to the basic tubular framework of the centre section.

The nose structure of the Skeeter, bounded at its after end by a steel firewall, has to carry the weight of crew and equipment, inertia loads caused by flight manœuvres, and landing loads from the nosewheel. These loads are carried back to the centre section by two L-shaped beams, or main frames, which form the basis of a conventional light-alloy structure (see diagram on this page) comprising cross-beams, diaphragms, ribs, formers, stiffeners and skin and floor plating. This structure incorporates a battery box in the nose, control access panels in the floor plating, and control mounting beams which run up between the main frames to the control integrator box mounted on the upper transverse member. The nose-section structure is completed by the secondary tubular and strip framework of the Perspex canopy and the two jettisonable doors.

The rear-fuselage section, bolted to the centre section at five points, is of conventional monocoque construction, employing an Alclad skin (D.T.D. 610, 20 and 22 s.w.g.) riveted to frames, stringers and five external stiffeners. It encloses the shafting and two gearboxes of the drive to the tail rotor, while externally mounted are the tail-rotor hub itself and a revised tubular tailskid. All stiffeners on the cranked tail-section, with one exception, are internal (previous Marks of Skeeter employed external stiffeners).

Originally, the Skeeter employed a three-bladed tail rotor having blades of riveted light-alloy construction. This gave reasonably satisfactory control power, but the following difficulties arose as the development programme proceeded. Firstly, blade failures occurred under extreme conditions of flight testing in yaw-check manœuvres; secondly a heterodyne vibration occurred between the tail rotor and main rotor; and thirdly, with the increased engine power, the tail-rotor control system appeared not sufficiently stiff, thus creating yaw-control difficulties.

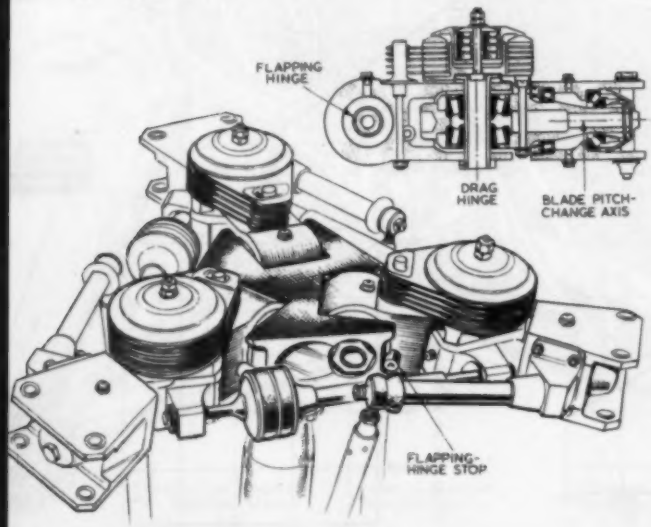
These troubles were cured completely by the adoption of the present tail rotor, a two-bladed unit of wooden construction, in conjunction with new tail-rotor controls having improved stiffness. The blade is now made up of a Hydulignum nose spar, a central ply sheet, and balsa filling; the whole covered with fabric and highly polished.

The pilots' dual flying controls comprise conventional control-column and rudder-bar installations, with the addition of duplicated collective-pitch levers, located on the left-hand side of each seat, each with a throttle twist-grip. From the pilots' main-rotor controls a series of push-pull rods and crank linkages transmits the appropriate motion, *via* the integrator (see control diagram on page 356) to the spindle of the control spider at the base of the main rotor shaft.

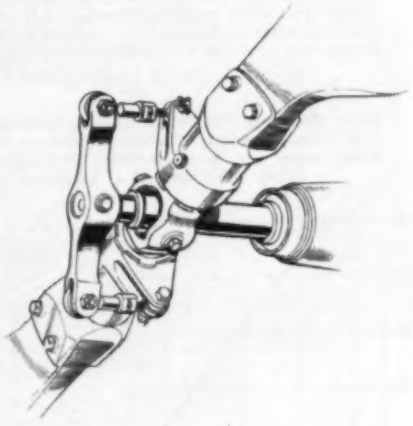
Fore-and-aft and lateral movements of the column control the cyclic pitch of the blades and so result in forward motion and rolling. Fore-and-aft and lateral trimming is accomplished by electrically operated screw jacks connected to the bases of centralizing springs on the control rods. These jacks are controlled by a four-way switch mounted on the handgrip of the starboard cyclic-pitch control column.

As shown in the diagram, the collective-pitch levers, also, are connected by a rod-linkage to the main control beam and so to the pendulum of the spider. Vertical movement of either lever produces a simultaneous alteration in the pitch of the three blades, resulting in vertical motion of the aircraft. The pitch lever is linked mechanically with the engine throttle so that an increase in collective pitch produces a corresponding increase in engine power. Conversely, a decrease in collective pitch closes the throttle.

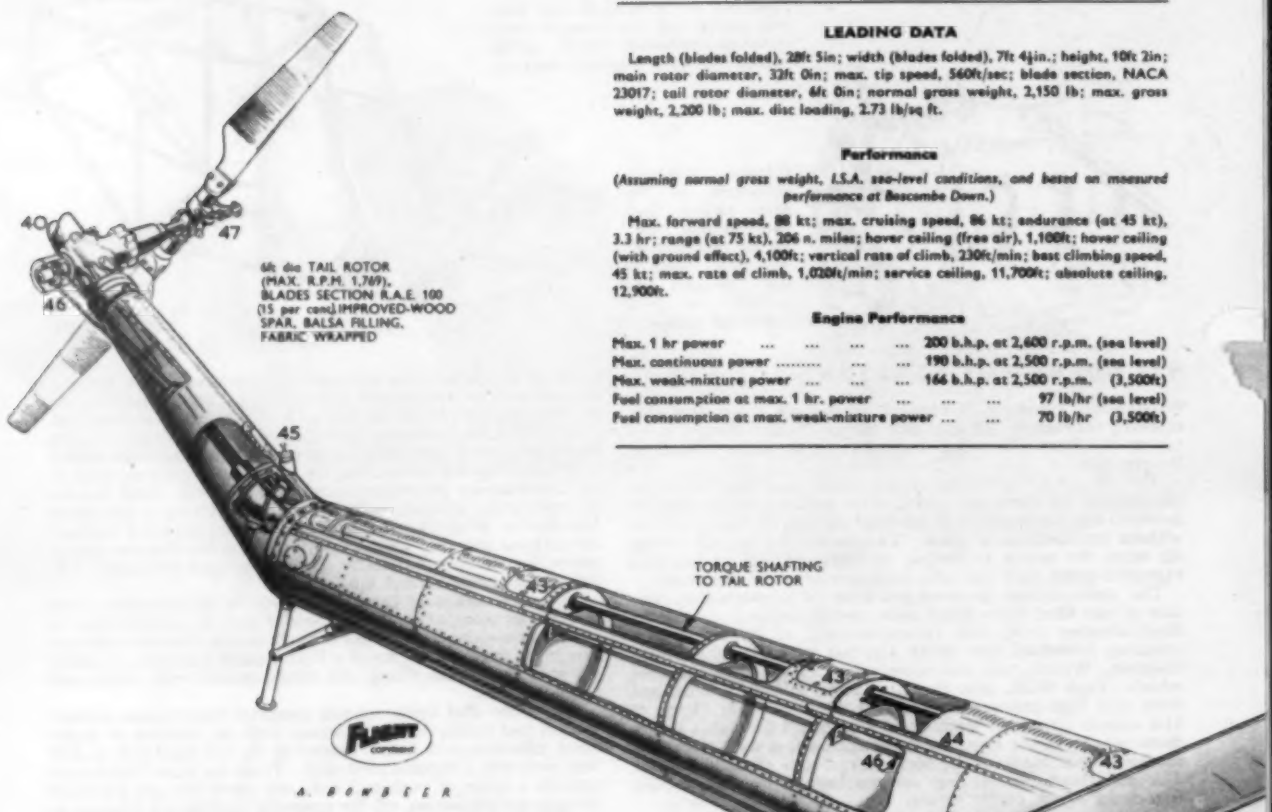
For practice autorotative landings, when almost full collective



Sketch (left) of main rotor-head, showing drag-hinge friction dampers and inter-blade snubbers. A new design of cyclic-pitch horn is employed on the Mk. 6.



Tail-rotor hub, showing details of pitch-change mechanism. Blades are of Hydulignum, ply, and balsa, fabric-covered.



LEADING DATA

Length (blades folded), 28ft 5in; width (blades folded), 7ft 4½in.; height, 10ft 2in; main rotor diameter, 32ft 0in; max. tip speed, 560ft/sec; blade section, NACA 23017; tail rotor diameter, 6ft 0in; normal gross weight, 2,150 lb; max. gross weight, 2,200 lb; max. disc loading, 2.73 lb/sq ft.

Performance

(Assuming normal gross weight, I.S.A. sea-level conditions, and based on measured performance at Bescombe Down.)

Max. forward speed, 88 kt; max. cruising speed, 86 kt; endurance (at 45 kt), 3.3 hr; range (at 75 kt), 206 n. miles; hover ceiling (free air), 1,100ft; hover ceiling (with ground effect), 4,100ft; vertical rate of climb, 230ft/min; best climbing speed, 45 kt; max. rate of climb, 1,020ft/min; service ceiling, 11,700ft; absolute ceiling, 12,900ft.

Engine Performance

Max. 1 hr power	200 b.h.p. at 2,600 r.p.m. (sea level)
Max. continuous power	190 b.h.p. at 2,500 r.p.m. (sea level)
Max. weak-mixture power	166 b.h.p. at 2,500 r.p.m. (3,500ft)
Fuel consumption at max. 1 hr. power	97 lb/hr (sea level)
Fuel consumption at max. weak-mixture power	70 lb/hr (3,500ft)

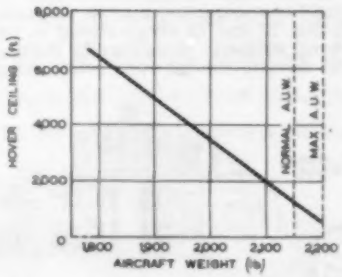
SAUNDERS-ROE SKEETER . . .

pitch is applied just before touchdown, the throttle/collective-pitch linkage must be disconnected. This is accomplished by means of a twist-grip over-ride against a spring load on the throttle control linkage, with a lock which can be immediately released if power is required. Once the twist-grip is locked, full collective pitch can be applied with the engine idling.

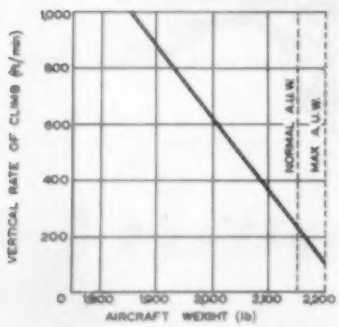
In normal use, the twist-grip handles to the collective-pitch lever give an over-riding throttle control, so that the power output of the engine may be matched to the rotor power requirements. The twist grips are mechanically linked together. To enable the collective-pitch lever to be set in any desired position, or the "feel" to be adjusted, a friction clamp is provided on the starboard side of the control box, between the pilots' seats. The starboard throttle twist-grip is similarly fitted with a knurled friction-nut ring below the grip itself.

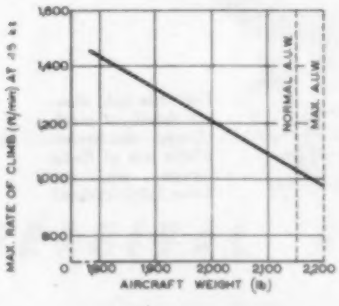
The pitch-change mechanism of the tail rotor, which is of the "see-sawing" type, is actuated by movement of the rudder pedals. Cables from these pedals run back to a short chain which passes over a sprocket on the end of the tail-rotor gearbox. The sprocket is attached to a screw-jack assembly which, in turn, operates a

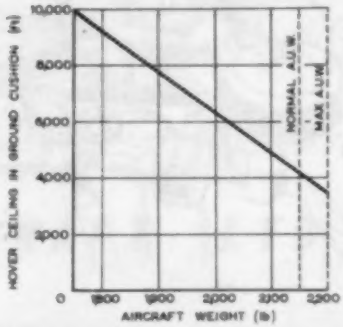
(Concluded at foot of page 374)



Below, climb performance: (left) vertical climb at max. one-hour power (200 b.h.p.); (centre) max. rate of climb at max. continuous power. Right (upper and lower), hovering performance at max. one-hour rating. Sea-level I.S.A. conditions are assumed.

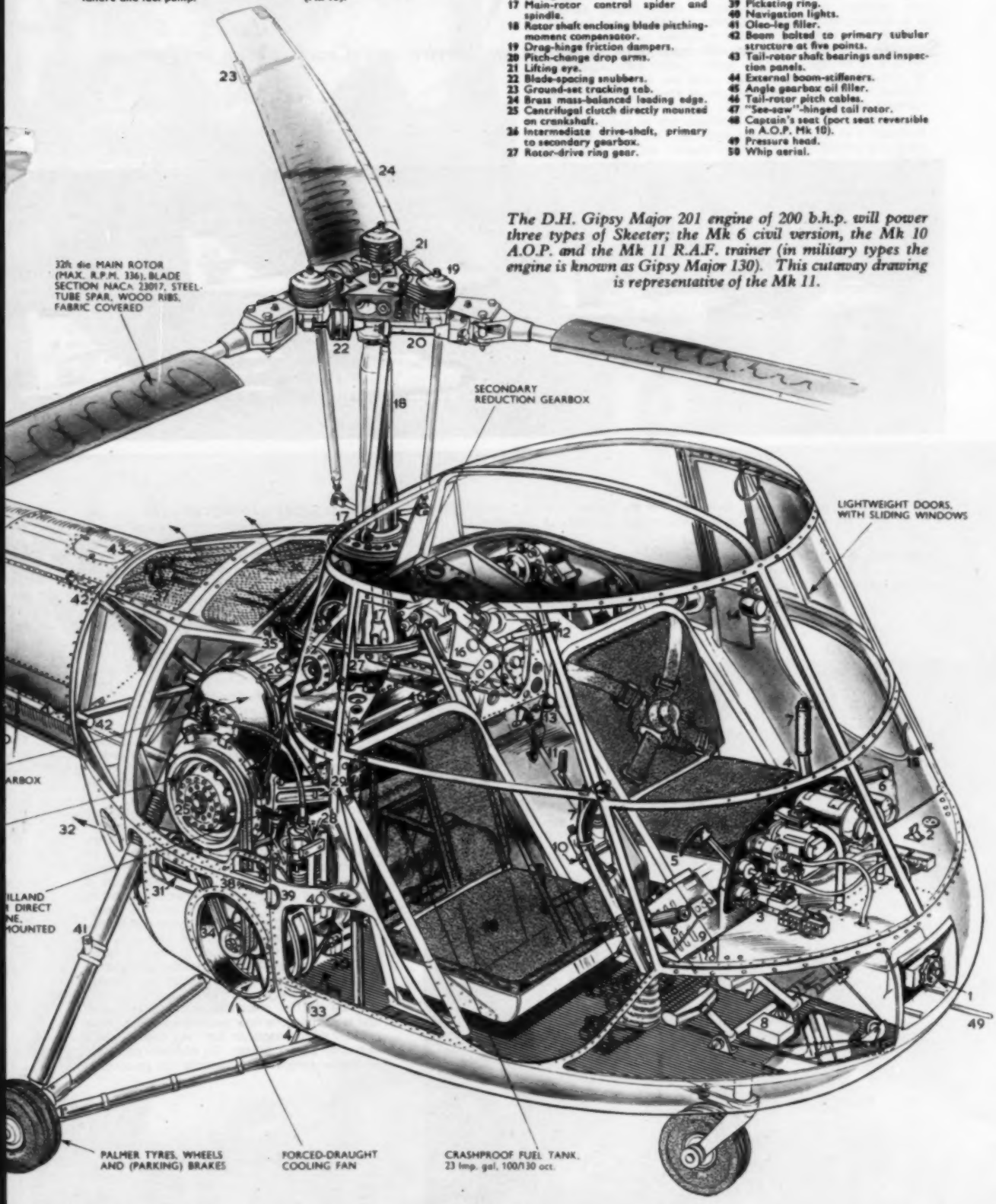






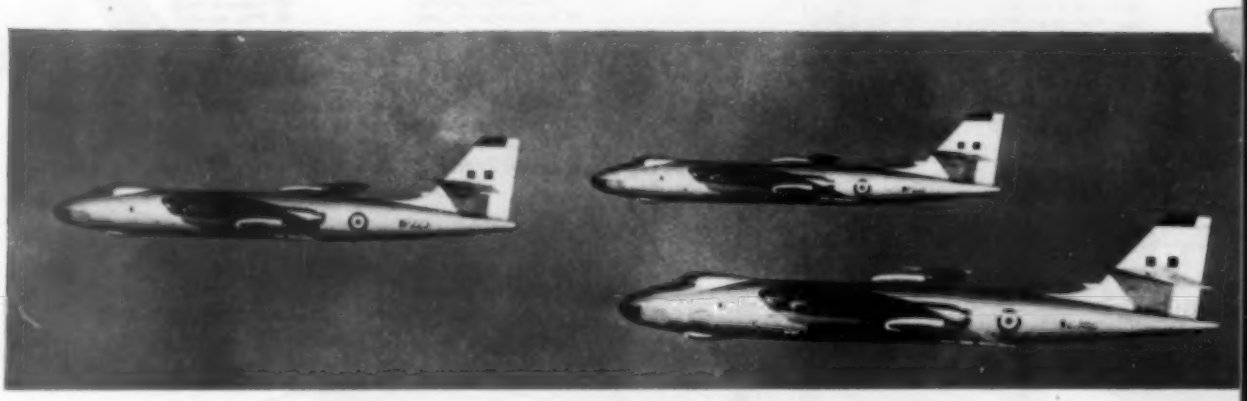
1 Varley 24v 25A/H lightweight battery.
2 Booster pump ground-test socket and switch.
3 Flexibly mounted instrument panel carrying blind-flying instruments, fuel contents, engine and transmission oil temps., engine and rotor tachometers, boost, cyl. head temp., warning lights for fire, generator failure and fuel pump.
4 Parking-brake handle and cable.
5 Clutch override control.
6 Dual collective-pitch/throttle levers.
7 Dual cyclic-pitch control-columns (port carries four-directional trim switch).
8 Dual tail-rotor-pitch rudder controls (with heel-deflecting safety block).
9 Radio. P.T.R. 61 (Mk 11), A.62 (Mk 10).
10 Electric trimming actuators (cyclic-lateral and cyclic fore-and-aft).
11 Fuel and oil on/off cock.
12 Rotor-brake handle with safety cord across No. 13 items.
13 Cartridge starter toggle, Ki-gass primer and on/off cock.
14 E2A magnetic compass.
15 Door jettison handles.
16 Collective and cyclic-pitch control linkages.
17 Main-rotor control spider and spindle.
18 Rotor shaft enclosing blade pitching-moment compensator.
19 Drag-hinge friction dampers.
20 Pitch-change drop arms.
21 Lifting eye.
22 Blade-spacing snubbers.
23 Ground-set tracking tab.
24 Brass mass-balanced leading edge.
25 Centrifugal clutch directly mounted on crankshaft.
26 Intermediate drive-shaft, primary to secondary gearbox.
27 Rotor-drive ring gear.
28 Rotor tachometer generator.
29 Engine and gearbox mounting beam.
30 Engine cooling duct.
31 Oil cooler.
32 Oil cooler airflow.
33 Oil drains collector tank (from fan).
34 Double-belt driving fan.
35 Rotor brake.
36 Expanded-metal panels.
37 Tail-rotor shaft flexible coupling.
38 Step.
39 Picketing ring.
40 Navigation lights.
41 Oleo-leg filler.
42 Beam bolted to primary tubular structure at five points.
43 Tail-rotor shaft bearings and inspection panels.
44 External boom-stiffeners.
45 Angle gearbox oil filler.
46 Tail-rotor pitch cables.
47 "See-saw"-hinged tail rotor.
48 Captain's seat (port seat reversible in A.O.P. Mk 10).
49 Pressure head.
50 Whip aerial.

The D.H. Gipsy Major 201 engine of 200 b.h.p. will power three types of Skeeter; the Mk 6 civil version, the Mk 10 A.O.P. and the Mk 11 R.A.F. trainer (in military types the engine is known as Gipsy Major 130). This cutaway drawing is representative of the Mk 11.


32ft dia MAIN ROTOR (MAX. R.P.M. 336). BLADE SECTION NACA 23017, STEEL-TUBE SPAR, WOOD RIBS, FABRIC COVERED
SECONDARY REDUCTION GEARBOX
LIGHTWEIGHT DOORS, WITH SLIDING WINDOWS
PALMER TYRES, WHEELS AND (PARKING) BRAKES
FORCED-DRAUGHT COOLING FAN
CRASHPROOF FUEL TANK. 23 Imp. gal. 100/130 oct.

V-FORCE IN BEING

Squadrons of Vickers-Armstrongs Valiants in Service and Crack Crews in Training



Formation flying is naturally not a normal part of the Valiant training syllabus, but the "vic" above shows it to be well within the capability of the pilots.

Though large, the Valiant is reported to be manœuvrable and very pleasant to fly. All flying controls are hydraulically powered, but provision is made for manual reversion. Loads proportional to airspeed (sensed from the intake at the root of the fin) are fed to the control column to give artificial feel.

VICKERS - ARMSTRONGS Valiants, the most expensive and complex aircraft yet issued to the R.A.F., are now in service with three squadrons of No. 3 Group, Bomber Command. Aircraft and crews of the new units, Nos. 138, 214 and 543 Squadrons, are already deployed at their operational airfields, and the crews for a fourth squadron are undergoing the highly specialized and arduous training which is laid down for Valiant crews. The training is given by No. 232 O.C.U. at Gaydon, Warwickshire (G/C. B. P. Young), which runs ground schools, a Valiant flight-simulator and two flights of Valiants, and some Canberra T.4s. Last week we were allowed to visit the station for the first time, and some details were released of the equipment of the Valiant and of how the crews are trained.

It was made clear that the Valiant is exceedingly complex, though pleasant to fly and not abnormally prone to unserviceability. But so much of the nation's resources are tied up in the equipment that the risk of losing a Valiant through any kind of crew inefficiency could not be accepted. Moreover, the task of delivering a nuclear weapon—and the Valiant was said to be capable of delivering any one of a number of types—could not be entrusted to any but the most skilled and reliable crews. Thus a new high standard of flying and bombing skill is being set and the cream of the R.A.F. is being taken to form the new V-force.

The fine proportions of the Valiant belie its size, but it is nevertheless a large aircraft and many of its services are electrically operated. A great deal of electrical power is required, and is supplied by four generators (one at each engine) which together have the capacity of a fair-sized power house. In addition there are hydraulic systems for controls and pneumatic

Above, a new aspect of the Valiant—from "deck level," with refuelling in progress. Several features of the machine are in evidence, notably fuselage details, jet tailpipes and the main tandem-wheel undercarriage, which retracts outwards into the wing.

Sailing bat-like through a misty sky this Valiant of No. 543 Sqn., photographed from a Fairchild Packet, has the stump of a flight refuelling probe mounted in the nose. The ridge running alongside the canopy is presumed to be connected with the probe installation. An extra air scoop also figures on the fuselage side.

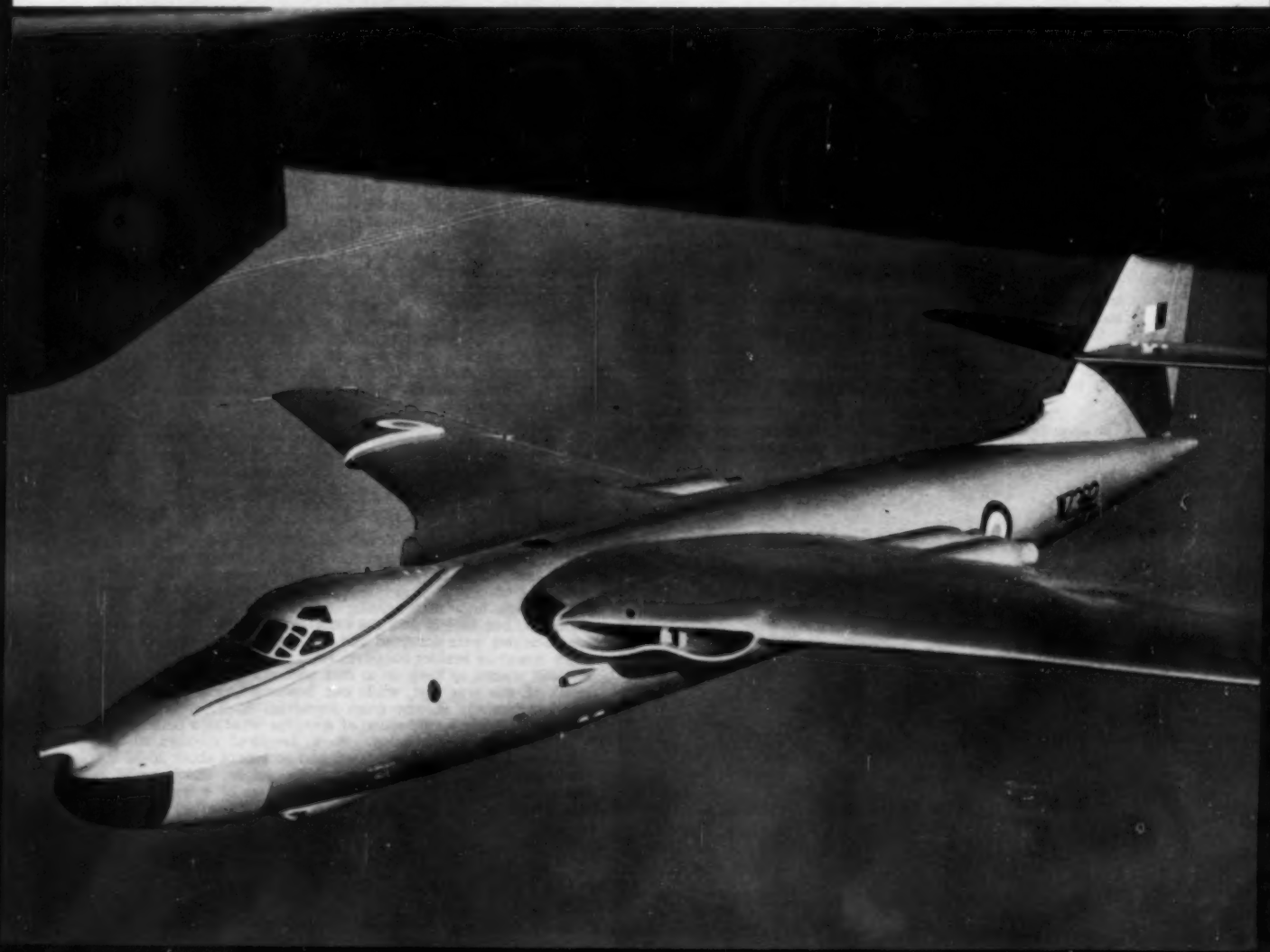
systems. Many of these are duplicated, and some even triplicated. As far as performance is concerned nothing can be said about the Valiant except that it is generally superior to the American B-47, especially in ceiling. A flight refuelling probe seen on the nose of a Valiant of No. 543 Sqn. also indicates that the machine can be given global range.

Select is the keyword for the crews and some of the special qualifications needed for Valiant captains are detailed in our editorial comment. Each crew consists of a captain, co-pilot, navigator plotter, navigator radar bomb-aimer and a signaller. The latter will soon have the new Air Electronics Officer rating. All sit together in a pressurized cabin in the nose, the two pilots side-by-side in front and the others facing rearwards below and behind them. The crews report very favourably on the comfort and handling of the machine.

Since the R.A.F. has now adopted I.L.S. as a standard approach aid, the Valiant is fitted with a Smiths autopilot with an approach coupler which will allow automatic I.L.S. approaches in poor weather down to a height of 200ft. Talk-down approaches with the Decca airfield control radar Mk. 7, now installed at many bomber airfields, can also be made with cloud ceilings down to 200ft, though limits for both types of approach will be lowered in the not-too-distant future.

When the crews leave Gaydon after three months of training, they have completed four weeks of ground school, 50 hours in Valiants and the pilots have over 20 hours in the simulator. Shortly afterwards they can be expected to reach the coveted "select" standard.

The Valiants in service are of the B.1 mark, powered with four Rolls-Royce Avon turbojets, each delivering a five-figure thrust. Provision is made for under-wing fuel tanks and for rocket-assisted take-off.



ROY CHADWICK

His Life and Work Discussed in a First Memorial Lecture

INTRODUCING the First Chadwick Memorial Lecture, *The Life and Work of Roy Chadwick*, Mr. H. Rogerson, M.B.E., A.M.I.Mech.E., F.R.Ae.S., who retired from the Hawker Siddeley Group last year, said that he was well aware that there were others still active who were better able to recount Mr. Chadwick's early activities with Avros. Particularly he thought of Sir Alliott Verdon Roe, Sir Roy Dobson and Harry Broadsmith. Other early colleagues and mentors—John Lord, H. V. Roe and R. J. Parrott—were no longer with us.

Mr. Rogerson was speaking before the Manchester Branch of the Royal Aeronautical Society on March 21st at The Reynolds Hall, College of Technology, Manchester. He referred to an intimate friendship of forty years working for and with Mr. Chadwick, who, he recalled, was born on April 30th, 1893.

As a schoolboy [said Mr. Rogerson] Chadwick had one interest only and that was fixed-wing flying machines. His heroes were the two Wrights, S. F. Cody and A. V. Roe. As boys he and I sat side by side in the local church choir, and while most of us appeared to give rapt attention to the half-hour sermon, Roy was usually sketching the argosies of the skies of his boyish dreams. In the middle 1920s he tried to work up an enthusiasm for rotating-wing aircraft, but failed to convince himself.

Before he devoted the whole of his working life and almost all his leisure hours to aeroplane design, Chadwick was quite a fair artist and violinist, and I have no doubt this was evidenced in a secondary way in many of his designs. After leaving school he took a post in the drawing office at British Westinghouse, where his father was a departmental chief, and came under the very encouraging influence of his chief draughtsman G. E. Bailey (now Sir George Bailey). Later, in the machine shops, he worked with Tom Fraser, who during the 1939-45 war controlled the manufacture of hundreds of Lancasters at Metropolitan Vickers.

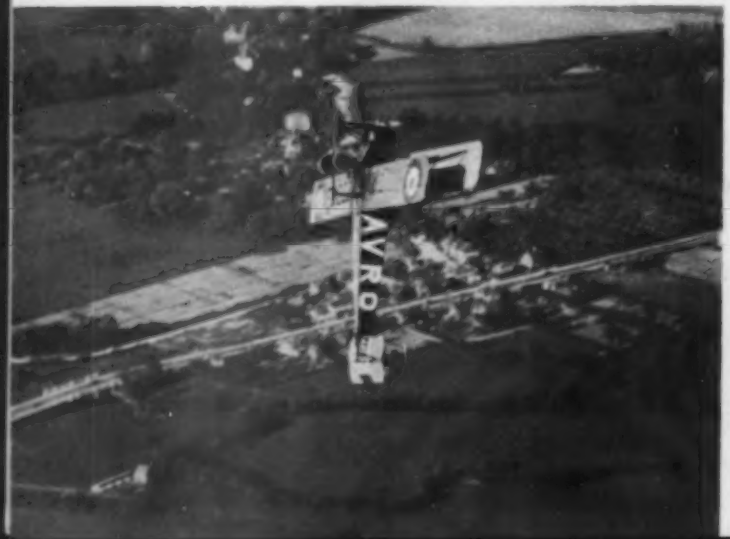
During the period before the First World War Chadwick eagerly followed the fortunes of the local pioneer, A. V. Roe, and eventually persuaded A. V. to take him on as a daughtsman under R. J. Parrott—at Brownfield Mills in 1911. His unbounded enthusiasm and unsparing energy soon won A. V.'s approval and A. V. "fathered" him, rather than employed him, in those early days, when orders were few and money scarce.

At the time when Roy Chadwick entered the design office the general lines of the Avro tractor biplane were in process of being stabilized, although A. V. still had a great regard for the monoplane layout, as evidenced by his enclosed cabin monoplane design in 1912. But I look upon the first few years as covering the development of the Avro 500, which was built in 1912. The result of this was that Chadwick's first few years were formative ones, during which he began to appreciate the necessity for pleasing the user—at this period the flying instructor—and he would spend a large amount of design time on the cockpit layout and the harmonizing of the three flying controls.

Considering the Avro 500 of 1912 as the prototype of the 504 series, this development period continued almost unbroken until 1924, when the 504N with the Armstrong Siddeley Lynx engine was put into production for the R.A.F.—an amazing life of a basic design which was an accepted trainer from 1914 until about 1930.

"Flight" photograph

The never-to-be-forgotten Avro 504K, with the design and development of which Roy Chadwick was intimately associated.



In the early days of the 1914-18 war the 504K performed many rôles other than flying training — particularly I call to mind the bombing of the Friedrichshafen airship sheds on November 21st, 1914, and successful Zeppelin straffing in early 1915. But in 1916-17 the 504J had made such a name for itself as a trainer that, when the Gosport system of training was evolved by the late Col. Smith Barry in 1917, the 504K was standardized as the trainer for the Allied Air Forces. The demand was so great that in 1918 the programme was for 500 aircraft a month, of which the parent firm had to produce almost half.

While the 504 design was being finalized in 1916, A. V. made schemes for a twin-engined bomber with the front gunner and bomb-aimer in the nose and a gunner just aft of the mainplanes. The detail design was left to Chadwick while A. V. concentrated on the difficult task of evolving a horizontal tier stowage of the bombs. This design passed through many phases with different engines and armament. On the first three the power eggs were fitted approximately mid-way between the upper and lower wing, although Chadwick was not himself convinced that this was the optimum position, and on later developments built in 1917 (Type 529A) two 210 h.p. B.H.P. engines were fitted on cradles on the upper surface of the lower planes.

Still further developments in 1918 were fitted with 300 h.p. Siddeley Pumas and A.B.C. Dragonfly engines.

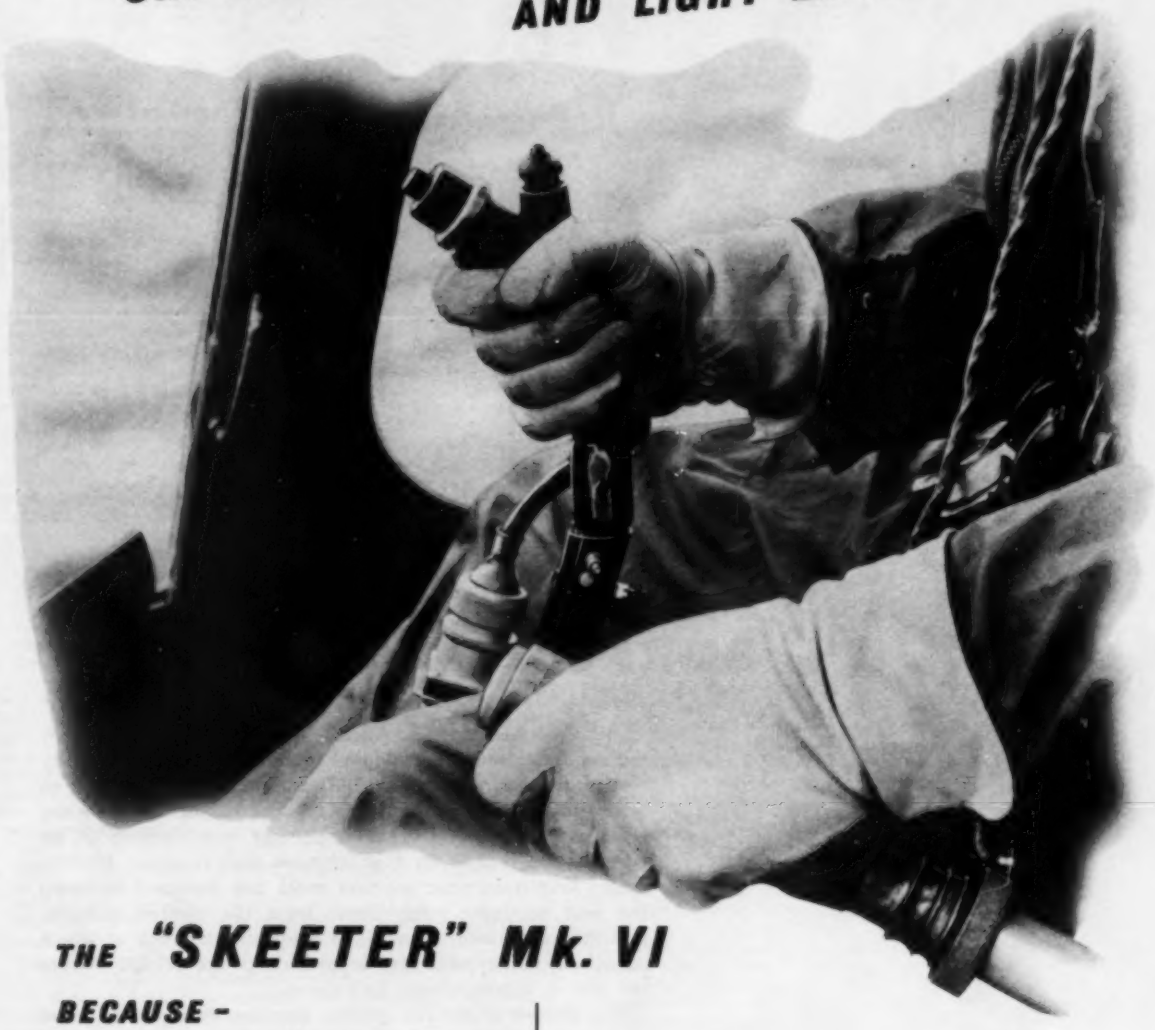
The optimum positioning of power units received a great deal of Chadwick's attention as evinced in his most outstanding success, the Lancaster, where he disregarded advice regarding the best vertical position of the engines for minimum drag at top speed, and adopted a position more favourable at a higher lift coefficient, which turned out to be good policy as the loaded weight and operational altitude went up.

A two-seater fighter, Type 530, was produced in 1917, and incorporated drooping trailing edges—forerunners of the landing flaps of two decades later. It must be admitted, however, that in the opinion of many this aircraft was not as good as Barnwell's famous "Brisfit" and it did not go into production.

As an indication of his versatility, Chadwick had considered the importance of rapid manœuvrability for the single-seat fighter, which had become standardized towards the end of the 1914-18 war, and he did not subscribe to the generally adopted theory that this must be obtained by reducing the distance between the c.g. and the neutral point, *i.e.* bringing the c.g. back. Rather did he favour a fairly stable aeroplane with very rigid structure coupled with powerful and well harmonized controls. To test his ideas he designed a little "1½-plane" fighter, with welded-steel Warren-girder interplane bracing, which was built as a private venture and fitted with a "borrowed" 110 h.p. Le Rhône engine. This turned out to be a delightful aeroplane to handle, extremely manœuvrable and without tricks or vices; but our methods of trying to obtain official approval were rather unorthodox and were frowned upon. Various well-known fighter pilots were invited to fly it on their off-duty days and were asked for opinions, with the result that the aeroplane became a topic of general conversation in the messes and came to the notice of the heads at the Air Ministry. I need not add that this aeroplane did not go into production.

With the cessation of hostilities in 1918 there was a serious glut of aircraft for training and few pilots to be trained. In fact there were some thousands of 504Ks thrown on the market, including of course, many that had not been made by Avros. Hopes were high of receiving orders from Canada and other countries, but firm orders were not forthcoming although many specifications were accepted and tendered for. It appeared that other countries besides ourselves found themselves short of cash, but still wished to keep up to date with our design trends. The result of this was that, while our business chiefs maintained a small but steady income from joyriding, A. V. and Chadwick longed for the re-introduction of what for want of a better name, I called low-powered flying. A. V. favoured a return to wing loadings of the order of 3 lb/sq ft and powers of about 20-30 h.p. on aeroplanes of about 600 lb all-up weight, which could be flown at 40 m.p.h.—within the boundaries of a large field, if desired, purely for the sheer joy of flying. Chadwick wished to

UNRIVALLED FOR TRAINING AND LIGHT LIAISON



THE "SKEETER" Mk. VI

BECAUSE –

The handling qualities, due in part to its three-bladed fully articulated rotor, are just those found in the larger types of helicopter. It is not difficult to fly, and the manoeuvrability is exceptional.

The throttle may readily be disconnected from the collective pitch lever, permitting practice autorotative landings without stopping the engine, and the engine may safely be left running on the ground.

The engine of 'One Hour Power' rating gives consistent and undiminished performance.

All maintenance can be done from ground level, except for the main rotor hub which is reached by using footholds on the helicopter structure.

Vision from the cockpit is unusually good, with a wide aspect rearwards.

A manual control of the centrifugal clutch prevents overloading of the rotor system when starting.

These are some of the features of the Skeeter helicopter which commend it for its chosen duties. Each of them contributes towards the economy which is a feature of its initial and operating costs.

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Squadron Leader J. S. Fifield, D.F.C., A.F.C., by a recent successful ejection at ground level, demonstrated the capability of the latest Martin-Baker fully automatic ejection seat to bring about safe escapes near the ground at low forward ejection speeds. A further important requirement of an ejection seat lies in its high altitude performance. Martin-Baker fully automatic ejection seats are designed to bring the seat occupant safely down from the ejected altitude, stabilised and under control, to a selected altitude at which parachute deployment and separation of the occupant from the seat is automatically performed.

The altitude of the live ejection demonstrated at Chalgrove on October 25th was over 40,000 feet, and the altitude of separation 10,000 feet.

Martin-Baker

AIRCRAFT COMPANY LIMITED

ROY CHADWICK . . .

go what he considered one stage farther, and design an aeroplane suitable for cross-country touring with rather heavier wing loading and about 40-50 h.p. Now, 37 years later, I am not quite sure which was right. In fact there still seems to be an outlet for both types.

As in many cases the availability of powerplant decided the issue, there being no very light motor car or cycle engines suitable for the ultra-light aeroplane, whereas A. V.'s 35 h.p. Green engine of 1910 had been preserved intact by Mr. Fred May of the Green Engine Co. and the whole of the manufacturing drawings were still available. The outcome was that the Avro Baby was designed and made round this overhauled engine, and a delightful little aeroplane it turned out to be, cruising at about 65 m.p.h. with a fuel consumption of about 35 m.p.g. Such was its success that a small production line was laid down at Hamble, and Peter Brotherhoods of Peterborough undertook to make the engines.

The Baby was a staggered biplane of 25ft span and a gross weight of just under 900 lb, and as proof that it was a practical touring vehicle, we may instance the winning of the Aerial Derby Handicap Race in 1919 and 1920, and Bert Hinkler's non-stop flights from Croydon to Turin and Riga. Later he flew 800 miles from Sydney, Australia, to his old home town Bundaberg, where he landed in the main street. Shortly after, Hinkler piloted the Baby to success in the Grosvenor Challenge Cup Race.

It might not be out of place to put on record the not unimportant part played by Hamble from 1916 onwards. I call to mind Faireys testing a seaplane with a Rolls engine with a two-speed gear ingeniously contrived from the epicyclic reduction gear, and at the end of 1917 a hush-hush aeroplane from Farnborough that we used to call (perhaps disrespectfully) "Bill Farren's Futuristic Flying-boat."

The Baby was also fitted with floats but, because of the low power, was difficult to unstick from smooth water. A two-seater land version was built, which Hinkler and I took to 11,000ft without experiencing wallowing.

After the Armistice Chadwick had become an efficient pilot under Allan Hamersley's expert tuition and, whenever an opportunity occurred, used to cruise round the country in the works Baby until on one such flight he crashed into the garden of Hamble vicarage, then occupied by A. V.'s brother the Rev. Everard Verdon Roe. Although the crash was from a low altitude, Chadwick sustained multiple injuries which very nearly cost him his life. I well remember visiting him in a nursing home in London, and knowing the extent of his main injuries enquired after each one individually. The following is typical of the conversation which took place:—

"Have they fixed your arm up?"

"Yes, the broken ulna and the radius have been repaired by silver plates and rivets."

"And the smashed top of your femur?"

"Oh they have fastened that together with four-inch woodscrews."

"And what about the kneecap which was in four distinct pieces when I visited you in the Southampton Hospital?"

"Oh that has been fixed up with wire 'rivets' just like those they use to repair household pottery."

However, such was his vitality and urge to live that he returned to his task with fresh energy, but promising to give up solo flying.

In an attempt to revive the triplane configuration, 504K wings and other components were incorporated in a passenger-carrying triplane, the 547, in 1919. Two prototypes were built and the second, fitted with a Puma engine, was entered in the Passenger Aeroplane Competition then taking place. It was flown by Allan Hamersley, but was not successful, due mainly to its being neutrally stable, whereas one of the tests was to prove ability to fly "hands off" for a reasonable length of time. In fairness to Chadwick it must be pointed out that he was out of action in hospital during the development of this type.

The revival of the Schneider Trophy Race in 1919 gave Chadwick the opportunity he had long wished for to design what at the time was a really fast single-seater. This design was powered by a 300 h.p. Puma six-cylinder in-line engine, but was chosen as a reserve aeroplane to the faster Sopwith seaplane.

The Type 539 was later revived as a landplane, with Napier Lion engine, with the Aerial Derby in view, but it crashed irreparably due to no fault of the aeroplane. This was a great disappointment as we were all sure it would have given Folland's Gloster Bamel a very good run for its money.

The Warren-girder-braced "1½-plane" referred to by the lecturer—the Type 531 Spider single-seat fighter, with 110 h.p. Le Rhône engine.

In 1920 the Air Force was being re-equipped to some small extent, and the single-engined Avro Aldershot bomber was Chadwick's first contribution. The prototype was largely of steel tubular construction and was fitted with the new Rolls Condor of 650 h.p., with the well-tried epicyclic reduction gear. Production models had the later Condor III, with spur reduction drive. An ambulance version styled the Andover was also produced, and one aircraft was later used as a flying test bed for the 1,000 h.p. Napier Cub and for the ill-fated Typhoon engines.

The reputation gained by the Aldershot was maintained by the Bison, a Lion-engined gunnery spotter for the Fleet Air Arm. To give the pilot optimum vision when landing on the deck he was positioned high up in front of the top plane, and the "forrard deck" sloped sharply down to the nose. Pilots had for some time been accustomed to having a horizontal section of fuselage nose in front of the cockpit to "con" by on approach and landing, and after many discussions we satisfied Hinkler by fitting a 4ft wooden rod horizontally on outriggers in front of the windscreen for the initial flights. Happily, Hinkler asked us to remove it after the first two flights, and the Navy pilots soon got used to the angle of the foredeck and appreciated the excellent view provided when approaching an aircraft carrier. Personally, however, I saw few three-point landings, which we always hoped for as aircraft were not then fitted with brakes.

Chadwick's next design was for a large twin-engined bomber and torpedo carrier named the Ava, which, when first flown was, to my knowledge, the largest all-metal aircraft—at least in this country. It had a biplane tail and twin rudders, an all-up weight of about 10 tons and carried the large 21in torpedo with 500 lb warhead, but the introduction of an 18in torpedo with a 500 lb head made this size of aircraft unnecessary for torpedo dropping.

In 1923 a serious effort was made to cater for the private owner who would buy an aeroplane for the simple pleasure of flying, and for the first Light Aeroplane Competitions at Lympne A. V. designed a monoplane and Chadwick a biplane. Air-cooled motorcycle engines developing 20 to 30 h.p. were fitted, and it is on record that Hinkler on the Blackburne-engined monoplane won the prize for the longest distance flown during the competition. Hamersley, on the biplane, fitted with a geared Douglas T.T. engine was joint winner of the altitude prize.

A year later the design of the light aeroplane was carried a stage further in the Avis powered by the twin-cylinder Bristol Cherub engine with a geared airscrew; but its success was marred by teething troubles with the prop-shaft gearing.

Continuing the development of the private-owner aeroplane, the Avian was produced two years later. It was somewhat bigger and heavier and was a dual-control two-seater fitted with one of Halford's Cirrus engines. It proved to be ideal for the light aeroplane clubs which the Government now decided to sponsor. The Avian appeared shortly after the early D.H. Moth, and many were the intense, but friendly, duels fought out at race meetings between Hubert Broad on the Moth and Bert Hinkler on the Avian—with honours, I think, fairly even. Among the outstanding flights made on Avians was Hinkler's solo flight to Australia in 15½ days, a record which stood for nearly 3 years until Kingsford Smith later covered the same route in 10 days on a more powerful Avian. Nor must we forget Miss Winifred Brown's superb piloting of her Avian in the King's Cup Race of 1930.

Meanwhile the basic 504 design was being further developed and, as the 504N with Lynx engine, still retained its position as the standard flying trainer of the R.A.F. The power had by now increased from 100 to 200 h.p., and the weight by 16 per cent, which many thought retrograde; but an attempt to revert to a lighter version with the revived 100 Mono engine met with only partial success in spite of its being named, very appropriately,

Successor to the great line of 504 trainers—the Avro Tutor.

The Avro bomber and torpedo carrier, powered with two Rolls-Royce Condor engines. The structure was entirely of metal.

ROY CHADWICK . . .

the Gosport. Not everyone remembered Gosport and the rotary engine was looked upon as messy and was not welcomed by the new generation.

In 1925 an Air Ministry order enabled Chadwick to design the Buffalo, our second torpedo-carrying aeroplane, with the same type of construction as the Bison, wooden biplane wings and braced steel-tube fuselage.

About this period development was proceeding in many firms on monocoque construction, and as a first stage Chadwick produced a design for a Lion-engined single-seater fighter with a wooden monocoque fuselage.

We considered this—the Avenger—a beautiful aeroplane, but the design was really in the nature of an exercise and one of the valuable lessons we learned was the difficulty of providing accessibility, when compared with the braced-strut fuselage.

Experience gained with the Avenger was incorporated in the Avocet, two of which were built for the Ministry in 1926. The Avocet was an all-metal, single-seat fleet fighter powered by a supercharged Armstrong Siddeley Lynx engine, and had a Duralumin monocoque fuselage and Dural spars for the wings, which were quickly detachable for stowing below decks.

The Antelope single-engined day bomber was produced in 1927, and again was mainly of Duralumin construction, but with a fuselage of rectangular section with Dural frames covered with Dural sheets.

It was during the design of this aircraft that Roy Chadwick and his colleague in Manchester, Roy Dobson, had many discussions about the advantages of Anthony Fokker's welded-tube construction, and an alternative fuselage of welded-tube construction was made for the Antelope. From a comparison of the two we learned that the welded tubular construction was singularly free from the modern bugbear—stress concentrations—and when J. D. Siddeley (the late Lord Kenilworth) took a financial interest in Avros in 1928, the first thing the two Roys did was to press for an agreement with Fokkers to obtain their know-how on welded construction.

This coincided with the design office moving from Hamble to the production works at Manchester, and there is no doubt that the close collaboration between the two Roys was vital to the success of the Avro welded construction, which is easy for the draughtsman but doomed to failure without the closest collaboration with the production staff. This was abundantly evident in later designs, such as the Avro Ten, which was virtually a redesigned and anglicized version of the successful Fokker F.VII/3m with three Lynx engines, and the smaller Avro Five special charter aeroplane with three Genet Major engines.

A successful development of the Avro X was the Avro 642 of 1933; it was somewhat larger, carrying up to 16 passengers and a crew of two, and was powered by two of the geared Jaguar engines which had been developed for Imperial Airways. A second model was fitted with four Lynx engines to the special order of Lord Willingdon, then Viceroy of India, who used it extensively with an Avro Ten as a tender for his entourage.

In 1929 the Air Ministry decided at long last that the ubiquitous 504 should be replaced as the standard trainer after 12 years superb service, and they instituted a competition which lasted for three years and in which many designs were thoroughly tested under Service conditions. The outcome was the acceptance of the Avro Tutor as the standard type for *ab-initio* flying training. On this design the fuselage was again of welded tubes, but the biplane wings had spars of thin steel strip, recently developed at Armstrong Whitworth Aircraft, Ltd., now an associate company.

During this last decade the large increase of speed, combined with an inappreciable increase in wing loading, had caused many designers concern about the penalties to be paid for the large shift of c.p., at top speed and in the dive, of the cambered aerofoils then in general use, and on the Tutor this was met by using an aerofoil with a reflexed trailing edge, namely R.A.F. 28. But, like many others, we soon realized that the ailerons of such aerofoils tended to float down as the speed increased and as a consequence the c.p. would wander back locally, offsetting the advantages of the reflexed section. However, on the Tutor, Chadwick had spent more time on the controls and cockpit layout than on the remainder of the design, and on this design the control column circuit moved the ailerons up, with the downward movement limited by the relatively stiff balance circuit.

A development of the Tutor was the 626 advanced trainer, designed mainly for export to countries who wanted their basic trainer to cover also bomb aiming, gunnery and photographic reconnaissance training.

The success of the Tutor as a trainer led naturally to schemes for a scaled-down version for the private owner and the flying clubs, and design work was precipitated by Sir Roy Dobson, in his secondary capacity as a super salesman, winning an order from the Irish Free State on Chadwick's brochure, before the design office had really got going. The outcome was the Cadet, powered by a Genet Major engine, which took the air about three months from this time. Despite its being overshadowed by the Tutor, the demand from private owners and flying clubs, both here and abroad, kept it in production for six years. Passenger-carrying cabin versions of both the Tutor and the Cadet were available and sold in small quantities.

From 1929 to 1934 it seemed that nearly every country was demanding a new design of trainer, and Chadwick's last design of biplane trainer was the 636 powered by a Panther engine.

Mr. Rogerson next described how the Type 652A Anson was developed from an Imperial Airways feeder machine, outlining the development of "Faithful Annie" at some length and recalling that over 11,000 were built in this country and Canada. Thereafter he was concerned with the Manchester, Lancaster, Lincoln, York, Lancastrian, Tudor, Ashton and Vulcan—types which, being comparatively recent, are also more familiar to our readers. At one stage Mr. Rogerson remarked, "I think it is accepted that the Lancaster marked the peak of Roy Chadwick's career and stamped him as outstanding among the world's designers. If figures are required, 7,366 were delivered; they dropped 600,000 tons of bombs on the enemy and nearly 7,000 tons of food to our allies, apart from being used to repatriate 74,000 ex-prisoners of war, which is a record of service which will surely stand for all time. When the Lancaster first went into operation a cruising altitude of 15,000ft was sufficient to defeat the ack-ack defences, but it soon became evident that this must be increased, and in the later stages of the war it was usual to cross the Channel at 22,000ft."

Roy Chadwick was killed when a Tudor II crashed just after take-off on a test flight on August 23rd, 1947, and the lecturer said that the end came as Chadwick would have wished it—at the height of his fame.

Recognition of his achievements had come in many ways—His late Majesty King George V conferred the C.B.E. on him, and Manchester University made him an Honorary Master of Science and an Associate of the College of Technology. He had long been a Fellow of the Royal Aeronautical Society and he was also a Fellow of the Royal Society of Arts.

"As no successful aeroplane design can be the fruit of one man's effort," said Mr. Rogerson, "but is the outcome of perfect teamwork, it might not be inappropriate to mention here some of Roy Chadwick's team in the early days at Hamble and of whom I have very pleasant recollections. There was Frank Vernon, now a Professor of Engineering in Canada; Jock Ratcliffe, now at Handley Page; George Dowty, Rowland Bound and Charles Blazdell of Cheltenham; Clifford Tinson of Bristols; C. H. Horrocks and Hugh Norwood, now outside aircraft; and lastly, Jim Turner and Ernest Brett, still faithful to the Avro design office. I have not included Sir Roy Dobson, although he was there, as he always insisted that his metier was producing and not designing aircraft."

". . . the Lancaster marked the peak of Roy Chadwick's career and stamped him as outstanding among the world's designers."

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(5) MERITS OF THE GNAT

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(a) A working height that makes servicing platforms unnecessary.

(b) A one-piece wing which, secured to the fuselage at only four main points and carrying no fuel tanks, armament, controls or landing gear, can be fitted and removed with little trouble.

(c) A single inspection panel that gives direct access to all engine accessories.

(d) A quickly-removable rear fuselage and a short cantilevered jet-pipe, which facilitate engine change.

FLIGHT EXPERIENCE WITH PROTOTYPES HAS SHOWN THAT THE SERVICING MAN-HOURS OF THE GNAT PER FLYING HOUR ARE UNUSUALLY LOW

WHERE THE GNAT ALSO SCORES

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(1) has a higher service ceiling, higher rate of climb and better manœuvrability.

(2) combines hard-hitting armament with exceptional stability at all speeds.

(3) can be transported more easily, and is less exacting in its airfield requirements.

(4) is easier to produce.

(5) costs far less to buy and operate.

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Vuia aeroplane at Issy-les-Moulineaux, 1906. Centre right, Vuia; centre left, bearded, M. Levavasseur, of Antoinette fame.

Modest Experimenter

By BERNARD ORNA

Vuia's Powered Flights: the Successes of a Little-known Pioneer

FIFTY years ago, on March 18th, 1906, at Montesson near Paris, a small aeroplane made a free flight of some forty feet after leaving the ground entirely under its own power. It was the first heavier-than-air machine of the kind to do so, and it fulfilled the belief of its pilot, Traian Vuia, a young Rumanian, in plans that had already been taking shape in 1902.

Vuia's achievement has been overshadowed by the greater successes of other pioneers, like Santos-Dumont, Blériot and Voisin, which very soon followed, and it has tended to be forgotten. Yet in general disposition Vuia's little monoplane set a pattern for aircraft to come and set the seal on the fact that a flying machine equipped with wheels could take off from the ground direct, and under the power of its engine alone. In this last connection it may be recalled that the Wright brothers at this epoch were using either an inclined launching rail or a catapulting device for an apparently unavoidable assisted take-off.

Traian Vuia was born in a small village in the Lugoj region of the Banat in August 1872. While at secondary school he became interested in mechanics and the idea of powered flight. He went to Budapest to study engineering, but financial circumstances compelled him to abandon this aim in favour of a course in law, so that he might find employment the sooner. His spare time he devoted to furthering his knowledge of aeronautics, and his designs centred first on a glider of the Lilienthal type with a pedal-driven propeller. As an outcome (he relates in autobiographical notes) by 1902 a more ambitious project began to take shape—a flying machine with an engine-driven propeller. That year he managed to travel to Paris for purposes of reading and research, where more information was available. He was to remain for two months, but his stay became almost a lifelong one. What he learned convinced him that his tentative plans were worthwhile and that he should do all he could to realize them.

Vuia testing the tractive power of his engine, March 1906.

In the discussions on flight then under way, Vuia joined the minority who held that the future lay with heavier-than-air craft, despite the attention that was focused on airships following the successes of vessels such as those of Lebaudy and Santos-Dumont (which latter readily flew a closed circuit of eleven miles). He prepared and submitted to the Academy of Sciences in February 1903 a paper which incorporated a description of what he called the "*aéroplane-automobile*", a light-weight monoplane that should take off from any normal road surface, fly along the course of roads or across country, and be easily piloted. The paper, which is entered in the annals of the Academy, was passed to the Aeronautical Commission—who, with their eyes fixed on airships and, one assumes, a disbelief in the practicability of the aeroplane as a flying machine, pigeon-holed it.

Four features of Vuia's project may be noted initially: the aeroplane was wheeled; it was to be powered by an engine and single propeller of the tractive type, at the front (Vuia did not accept the theory of some that the torque action of one propeller would overturn the machine); its ascent and descent were to be controlled by alteration of the inclination of the wings; and a rudder, at the rear, was to help in horizontal control in the air.

Vuia was not discouraged by the indifference of the Aeronautical Commission. He decided to have a machine built himself, and the financial help of a number of friends was fortunately forthcoming. The aeroplane was constructed at the workshops of Hockenjos and Schmitt, Paris, the two-bladed propeller being provided by the pioneer aeronaut and expert Victor Tatin. It was completed towards the end of 1905. A triangular tubular steel frame, on four wheels with pneumatic tyres, carried fuel tank, motor, controls and bucket seat for pilot. The two wings, mounted on top of the frame and making a single span, had a spread of 21ft and a width of 6½ft, and they could pivot as Vuia's first description had anticipated; based in shape on Lilienthal's "Bat" glider wings, they were of varnished linen and a light tubular steel and steel wire framework and they could be folded up.

Unable to obtain the power unit he required, Vuia resorted to designing one himself. It was of 25 h.p., and an account in *La Nature* (2e Semestre, 1906) describes it as being "a Serpollet steam unit, but modified to take carbonic acid, carried in liquid form and then vaporized [which] allows for a useful pressure to be obtained with a very light boiler . . . Burners are refuelled by petrol." *La Nature adds* "This modified usage of a steam motor is both interesting and original." In the event, Vuia's engine, though very ingenious, proved perhaps the weakest part of his bold design.

The first tests were made, with frame and engine alone, in December 1905, when a speed of 25 m.p.h. was attained, and resumed in February 1906. *L'Aérophile*, organ of the Aéro-Club de France, carried a first account of the machine in that month and commented "It promises well . . . It may afford an important contribution to the solving of the direct take-off . . ." At the time of its assembly and subsequent testing in February, Vuia's aeroplane was examined with interest by several personalities, amongst them Santos-Dumont, then leading aeronaut in France, Archdéacon, president of the Aéro-Club, and Victor Tatin. The machine was thus known to those most closely concerned with

(Left) Soldiers at the military field of Issy-les-Moulineaux were interested spectators as Vuia prepared for a flight during the summer of 1906. His machine, it will be seen, has been considerably modified in comparison with the March 1906 design shown on the previous page. (Above) Vuia's twin-rotor helicopter of 1922-23.

MODEST EXPERIMENTER . . .

plans for heavier-than-air craft, and its performance kept in view by them.

Testing with the wings in place was begun in March, near Montesson, where the machine was housed, and on the 18th there was the unpremeditated but memorable flight (in the presence of Hockenjos, a mechanic, and two of Vuia's friends from Paris). During the early afternoon, notwithstanding a slight cross-breeze, Vuia ran his machine along the roadway leading towards the Seine. After travelling some 150ft, the aeroplane gently left the ground, rose to a height of 3ft and flew on some 40 ft. The motor then suddenly stopped and the machine came down abruptly but evenly; as it landed the wind caught it and tipped it against a tree, damaging a wing and the propeller; Vuia was unharmed.

Vuia's report of the flight appeared in the April issue of *L'Aérophile*. He said that the result was a step towards proving that a wheeled aircraft was practical and not unduly difficult to handle, and he referred to his main problem as lying in the action of the motor.

The aeroplane was repaired and he set about testing it again, as from June, at Issy-les-Moulineaux, where a military training ground was sometimes available. A short "hop" is recorded as having taken place on July 1st, but Vuia was dissatisfied and made modifications to the machine before further trials, in August. By then others, too, were experimenting with aeroplanes, but during those months without success. Archdéacon, Blériot and Voisin tried machines with floats. Santos-Dumont endeavoured to use a launching "carrier" in the form of one of his airships, and, alternatively, an inclined aerial cable and catapulting device; finally he envisaged the necessity of a launching ramp for his machine, a biplane.

In August 1906 Vuia achieved new successes. On the 12th, the machine twice left the ground on flights of about 30ft. On the 19th, a fine day, he flew 80ft, at a height of about 8ft, but crash-landed. One cannot be sure, but the news seems to have reached Santos-Dumont; on the 21st he was still testing his aeroplane with the "carrier", but as from the next day he pursued trials without any such aids, running his machine along the ground under its own power. The September issue of *L'Aérophile* published accounts of the performance of Vuia's machine as communicated by him in a series of letters. Vuia spoke again of the inadequacies of his motor, which could run full out for only three minutes, and stated that he intended to devote further attention to the question of horizontal control.

An editorial note in that same issue may be quoted, as it is of much interest: "At a moment when similar experiments are under way or being planned it is only just to recall that M. Vuia is the first person in France to have really attempted, with a machine able to carry a man, the direct take-off of an aeroplane having a wheeled undercarriage."

About this time, the president of the Aéro-Club offered a prize for the first free flights in an aeroplane over a distance of 100 m (328ft). Commenting on Vuia's machine, another writer in *L'Aérophile* encouraged the inventor to enter for the competition. It is not known whether Vuia considered this; and it was of course Santos-Dumont who became the winner with a flight of 650ft at the close of the year.

Vuia did, however, become a member of the Aéro-Club de France. In October he demonstrated his machine before an official delegation from the Club, and received their congratulations. The aeroplane had been modified again and now had a horizontal tailplane as well as the vertical rudder.

Though unable to do as much as he might have wished, for lack of funds, Vuia continued his experiments in 1907, when Santos-Dumont was pressing ahead with new designs and Blériot, Tatin (working for De La Vaulx), Delagrange, Ferber, and then others, turned their attention also to wheeled aircraft. Flights were made in February and March; a day's attempts were described in *The New York Herald* of March 3rd under the heading "Vuia Aeroplane Makes a Successful Flight". In April the carbonic-acid gas motor was replaced by a 24 h.p. Antoinette petrol engine which Vuia had managed to obtain. The aeroplane was reconstructed and tested in June and July, the best flight being one of 70ft at a height of 15ft during the latter month. Reports appeared in *L'Aérophile* as before; a note in the June issue reminds readers that "The model 1 Vuia aeroplane, it should not be forgotten, was tested publicly in advance of all contemporary machines—from early in February 1906."

To judge by the *New York Herald* report, Vuia had in mind the building of a new and different aeroplane, but if this project did exist it was never realized. Short of funds and so without means of affording new machines, Vuia quietly withdrew from the scene in 1908. Tribute was paid to him in the October issue of *L'Aérophile* when an account of his work appeared in a series of "Portraits of outstanding aeronauts", and in *Les Oiseaux Artificiels* (Peyrey, 1909) the account was reprinted.

Vuia's story has a continuation nonetheless, and he concerned himself with aeronautics, in one way or another, for many years to come. During the First World War he rendered service to the French Air Force and helped develop planes for its use. A few years after, in 1922-3, he re-appeared briefly amongst actual experimenters, occupying himself now with the helicopter as a machine for which he saw a useful future.

L'Aéronautique of May 1923 described his helicopter at some length. It featured a double set of rotating wings, each side of the fuselage, turning in opposite directions on axes inclined slightly forwards. The machine was designed to rise at an acute angle after a very short run (no more than seven feet), and to travel at 15 m.p.h. By a strange coincidence the first flight was made on March 18th. The machine proved stable and answered readily to rudder control. But the motor was not a powerful one (only 8 h.p.) and in all no considerable results were achieved.

In the years that followed Vuia kept to his subject in a more academic manner, as a ready adviser to students and younger inventors. Just as he had believed in the potentialities of powered flight, so he was glad to help popularize the aeroplane as a means of travel and of bringing peoples together.

During the period of the Second World War, though already old, he was one of the founders of a group of Rumanians associated with the French resistance movement. He had acquired French citizenship in 1918, but in 1950 he accepted an invitation from the Rumanian government to return to his native land, where he was given a great welcome. In September of that year he died suddenly, the victim of heart failure.

Vuia has been described by those who knew him as a very modest man. Indeed, he never made any other claims for his own efforts than that they had contributed to the firm establishment in 1906-7 of powered flight as a practical proposition. His inventiveness has been shown, and another legacy is the design for a steam generator whose possible use in the production of power is so promising that it is today under active testing in Rumania.

The Vuia aeroplane and a preliminary "sketch" model have survived and are in the possession of the Aeronautical Museum in Paris, whose curator, M. Charles Dollfus, knew the inventor and plans a complete restoration of the machine. Another and close friend of Vuia's was the present president of Rumania, Dr. Petru Groza, and it is fittingly he who has written the preface for the first of two books* devoted to the work of a man who deserves the description of a very worthy pioneer, as much for his vision as for his part in the earliest development of the aeroplane.

**Traian Vuia: "Realizarea Zborului Mecanic-Marturii", Editura Technica, Bucharest, 1954. (Further to the references given in the text, this has been the source of much useful material.) See also: "L'Homme S'Envole", Sazerac de Forge, 1909; and "Histoire de l'Aéronautique", Dollfus et Bouché, 1932.*

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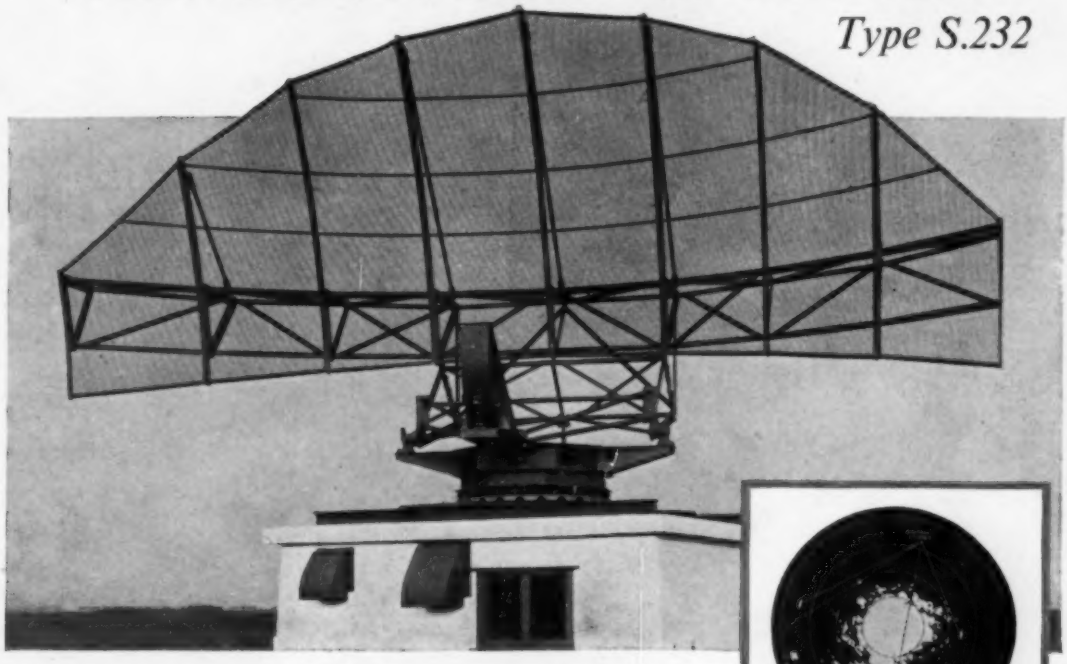

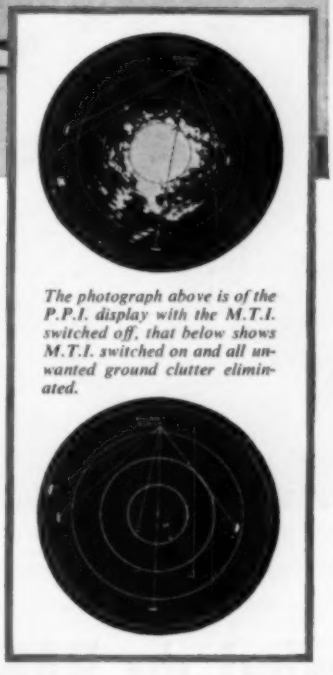

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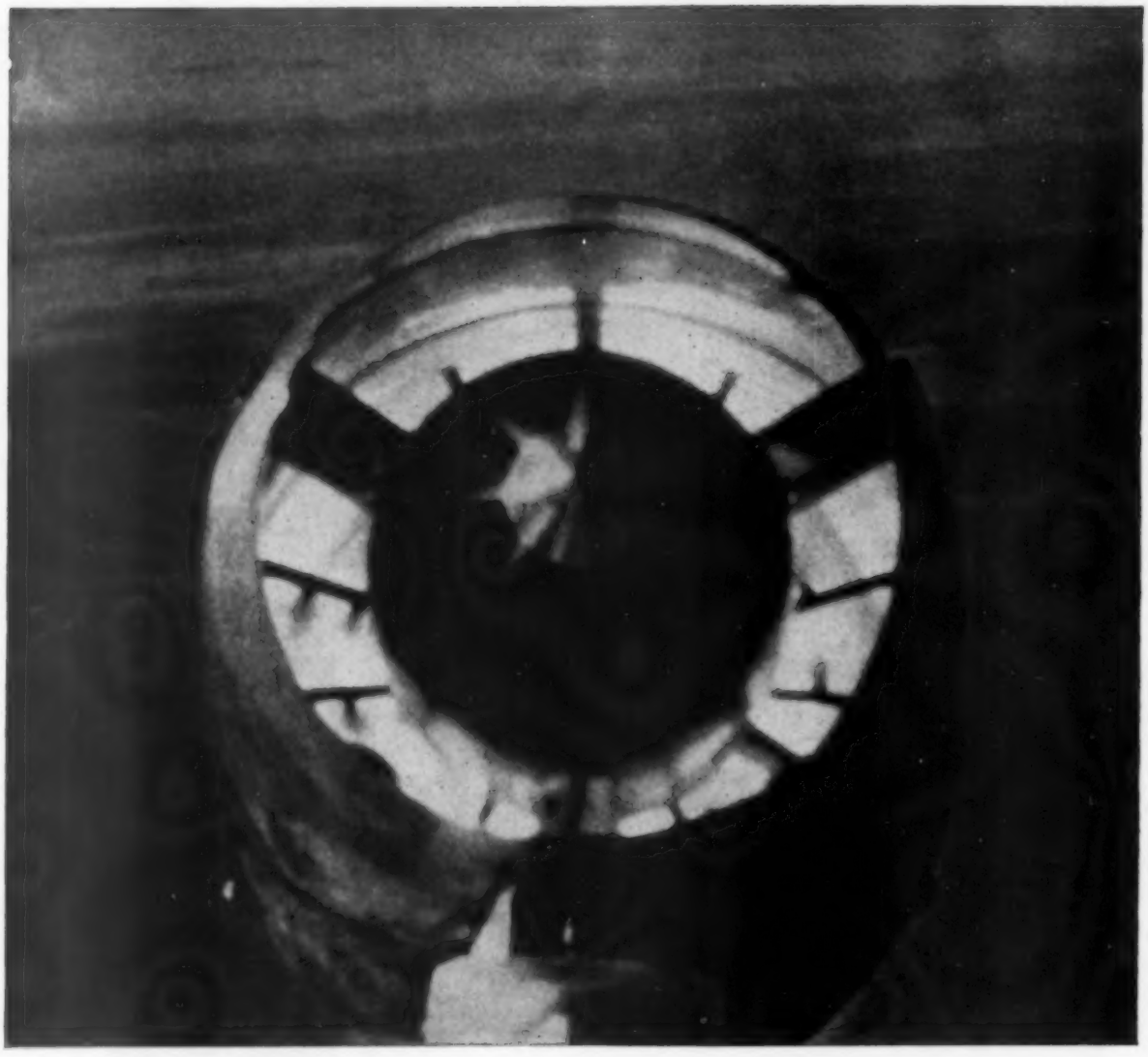

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One of the Comet photographs referred to below in the letter from Mr. Richard Dumigan.

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

CORRESPONDENCE

Transport and Monopolies

THE letter you published (February 24th) from "Icarus" is a sad one, first because the writer had to hide his name—an odious necessity in any free society—and second because much of what he says could have been written with equal validity 20 years ago when the first DC-3s were populating the world's air routes and Imperial Airways had the monopoly now held by B.O.A.C. None of the industries and trades that made Britain successful in the eyes of the world, and prosperous, started as monopolies. All the export industries upon which we depend for survival—shipping, ship-building, motors, radio and electronics and indeed the whole range of private enterprises—thrive because they are not monopolies. If they are run as a series of monopolies, the multiplicity of ideas of their various managements would not have the necessary scope, and England would be very much poorer.

By sticking for more than 30 years to the original misconception of the politician who set up Imperial Airways as a monopoly, England has signally failed to emulate in the air its leading place in sea trade. Moreover, by creating a monopolistic airliner procurement environment it has prevented the aircraft industry from holding a similar leading position in world airliner building to that which the British shipbuilding industry has won in the export of liners.

The lesson has been illustrated in British air transport over and over again in these 30 years, but never learnt. Until the favourable environment is created this new industry will not prosper to the extent that other British industries have in the past. Air transport was the first British industry that the State ran almost from its inception, and it is the first major British industry that has failed to prosper.

London, S.W.5. JOHN LONGHURST.

An American Camel Squadron

ALTHOUGH it is almost twelve months since the publication of your very excellent article on the history of the Sopwith Camel, I wonder whether the following information might still be of interest. At least it should be aired, if only for the sake of accuracy.

The 17th Aero Squadron sailed from Southampton for Havre on February 9th, 1918. "H.Q." Flight was assigned to 24 Squadron, R.F.C., at Martigny, "A" Flight to 84 Sqn. at Guizancourt, "B" Flight to 60 Sqn. at Ste. Marie Cappell and "C" Flight to 56 Sqn. at Baizieux.

The Squadron, as a whole, first crossed the line on offensive patrol on July 15th, 1918.

Sixty-six Camels were drawn from the British; consumption was 47. Serial numbers of 53 of them are available to any interested person. R. P. EVENS-GILHAM.

London, W.4.

Long Production Histories

YOU report in "Aircraft Intelligence" (*Flight*, February 3rd) the Douglas claim that the Skyraider has "the longest continuous deliveries of any combat airplane now in production."

Aren't Douglas being a bit presumptuous? Surely the Me109 must take pride of place, with perhaps the Heinkel 111 sharing the honours?

The Me109 was in production in 1939 and probably earlier and is still being manufactured. Or isn't the Spanish machine a "combat airplane"?

R.A.F. Tengah, Malaya. D. PENNINGTON.

[*The Spanish-built Me109 is regarded primarily as an operational and weapons trainer.*—Ed.]

Comet Enthusiasm

THE enclosed prints are, I believe, the only "still" snaps of Comet G-ANLO landing at Montreal Airport (its first from Toronto, and its demonstration here).

I would like to send the negatives, but too-strongly fear never seeing them again, and of all my more-than-6,000 aircraft pictures I prize them most! The wishful thinking, the ulcer-creating anxiety, the physical suffering (totalling 45 hours' waiting in continuous sub-zero weather) alone would qualify them for this position, but the Comet's beauty and the personal accomplishment for me is, I feel, too great to jeopardize in the mails over the Atlantic.

The enclosed photos were taken at twenty-five below (*at least!*) and are a little lacking in sharpness because of that; for, though I kept my German camera next to my body, the few minutes it was outside were enough to affect the emulsion and stiffen its opening (in fact, I had to pull it open!).

Interesting comments overheard by the writer at Dorval were these, which I believe sum up an opposing public opinion of the Comet in North America: Well-dressed North American-type meeting woman acquaintance—she: "Have you seen the Comet outside? Nice, eh?" He: "Oh yes, but it can't come anywhere near some of the stuff the Americans are turning out!" And this, at the T.C.A. hangar next to B.O.A.C., from a worker to the writer: "The Americans have nothing to compare with this!" Comment should be superfluous.

I have seen many pictures in your magazine of the Comet in the last couple of years, but never expected to see it in person.

Montreal North, Quebec. RICHARD DUMIGAN.

The Sperrin

A RECENT issue of the *Daily Express* hinted darkly at waste of money on Sperrin prototypes. Before deciding which lot of money was wasted and where it went, may I suggest that people:—

(a) remember when the Sperrin 1 could have been in squadron service,
(b) compare its performance with today's R.A.F. and U.S.A.F. types,
(c) take a look at a hypothetical Sperrin 2, which could have flown the year before last, geometrically unchanged except for a 2 per cent thinner wing and Olympus engines,
(d) compare these results with the types for which we are still waiting—power controls, Martian profiles and all!

Belfast. SLIPSTICK.

FORTHCOMING EVENTS

Mar. 30. British Interplanetary Society (Glasgow): "Space-ship Engineering," by P. H. Tanner, B.Sc.
Apr. 4. Air-Britain (London): Presentation of B.O.A.C. Recognition Trophy.
Apr. 6. R.Ae.S.: "Problems in Production and use of Modern Light Alloys," by G. Forrest, B.Sc.(Eng.), A.F.R.Ae.S., (at Belfast).
Apr. 6. British Interplanetary Society (Harrogate): "Speculations on Extra-terrestrial Life," by S. S. Kind.
Apr. 7. British Interplanetary Society: "Power Supplies and Telemetry for Instrument-carrying Artificial Satellites," by J. Foley, B.Sc., F.R.Ae.S., Grad.I.Mech.E., E. White and R. Wilkins.
Apr. 12. R.Ae.S. Section Discussion: "Aircraft Interior Layout."

R.Ae.S. Branch Fixtures (to April 10th):—
Apr. 2, *Derby*, "Atomic Energy for Aircraft Propulsion," by J. E. B. Perkins. Apr. 4, *Brough*, A.G.M.; *Weybridge*, "Glass for the Aircraft Industry," by Dr. A. J. Holland. Apr. 5, *Belfast*, main lecture (see above); *Isle of Wight*, branch prize lectures. Apr. 9, *Halton*, film, "We Saw It Happen." Apr. 10, *Boscombe Down*, "Engine Development," by Dr. S. G. Hooker; *Bristol*, "Titanium—a Survey," by Maj. P. J. Teed; *Glasgow*, film and A.G.M.

THE CONTRACTORS' DINNER

Boscombe Down Entertains the Industry

BOSCOMBE DOWN was again the venue, on Friday, March 16th, for the aircraft constructors' ("The Contractors") annual dinner as guests of the Aeroplane and Armament Experimental Establishment.

As always, it was a particularly pleasant occasion and, occurring so soon after the establishment of a new world speed record, it provided an early opportunity for well-deserved mutual congratulations on the parts of Peter Twiss, senior representatives of the Fairey company and officials of the Ministry of Supply. Unaccountably, there was no representative of the Rolls-Royce company at the dinner to hear the praise of the F.D.2's Avon.

A. Cdre. Ramsey Rae, commanding Boscombe, welcomed the guests, mentioning in particular the Chief of Air Staff, whose personal attendance was appreciated by all present. On behalf of the Establishment, and amid loud applause, A. Cdre. Rae congratulated the Fairey company and all others concerned in the wonderful performance of capturing the speed record by the largest margin ever achieved. He also commented on the arrival of the Vulcan at Boscombe Down.

Sir Frederick Handley Page, whose reply for the guests used to be one of the highlights of the contractors' dinner, again undertook this responsibility. His speech was as much appreciated as on previous occasions—and equally unreportable. He spoke of the graded steps to the Ministry of Supply—"one brochure after another"—and of the aircraft manufacturers "in outer darkness where people eked out a precarious existence trying to meet specifications which were never quite determined." He drew parallels from experience on his farm, where to arrange production was a relatively simple and quick matter and "even though one may have to wait seven years to establish the true value of the result, at least there are no modifications." He concluded on a more serious note by saying that if the industry was to maintain its position it would have to enjoy a greater freedom from Treasury control in order to exercise technical freedom as in the past.

It is only very rarely that the Chief of Air Staff is able to attend the contractors' dinner, and as far as we can remember this was the first occasion since the war. Air Chief Marshal Sir Dermot A. Boyle said he felt that the world's future, through the Air Force, depended greatly on the aircraft industry; thus he was very concerned with the health of the aircraft industry and with civil aviation also. There was still a shortage of civil aircraft of the right quality. Our industry had been quick to realize the requirements and with the Viscount and Britannia had done well in conditions of great competition. He felt that the Comet, thanks to the enterprise of its makers, would eventually have the success which was denied to it in the beginning. The Air Force admired its achievements and felt it would now succeed. The industry had gained in reputation out of the tragedy of the Comets.

Military aircraft had in some ways not been so successful as civil transports. The V-bombers would give a good account of themselves and for a period would be ahead of the world. The C.A.S. then went on to discuss the difficulties of producing military aircraft, adding that the operators of civil transports at least knew what would be wanted; but military requirements fluctuated according to politics. After the last war everyone had said there would be no more war and planned accordingly. Then came Korea; then guided missiles; then the call for more "inhabited" aircraft—which, said the C.A.S., would be with us for a long time yet.

He thought that the design and production side of the industry was doing very well, but it needed to go beyond this and do a little more for the baby after it had been sold. During his concluding remarks he said: "Would designers please listen a little more to their test pilots? It would be less embarrassing to take action the first time the pilots said something than when they said the same thing four years later." Today pilots were, of necessity, young and designers were older. There had been times, earlier, when both had been the same age. It was a pity that the country which had been the first to recognize the importance of air power was not today as air-minded as it should be.

Mr. C. F. Uwins (chairman, Bristol Aircraft, Ltd.) replied on behalf of the aircraft industry. Recalling that Martlesham had set a world-wide reputation for aircraft testing, he said that, despite fears to the contrary, Boscombe Down had become all that Martlesham was, and more. He thought that this was due to a considerable extent to "the wise choice of commanding officers who paused for a while at Boscombe on their way to higher office."

An additional speaker was Air Chief Marshal Sir John Baker, Controller of Aircraft, Ministry of Supply, who added his thanks to the hosts and his congratulations to Peter Twiss and Faireys.

C. M. WILLIAMSON'S HALF-CENTURY

TO mark the completion of 50 years with the Williamson Manufacturing Co., Ltd., Mr. Colin Williamson, the chairman, was presented with a silver tray and cut glass wine glasses at the firm's annual dinner and dance, held in London, March 16th.

Recalling conditions as they were half a century ago, Mr. Williamson said that the concern was then very much of a one-man band. He was proud to think that during those 50 years there had never been even a semblance of a strike. With all the modesty of long experience he added that whereas as a young man he thought he knew all the answers he felt that at least he now knew all the questions.

As would be expected at such a gathering, much that was said was of a domestic nature; but through it all ran a thread of interest concerning the tremendous effort made to perfect the new F.96 camera, now in production at Williamson's Reading factory.

K.A.C. CELEBRATE AGAIN

THIS year the annual party staged by King Aircraft Corporation, of Hillington, Glasgow, acquired for the first time an international aspect. In addition to some 120 members of the British aircraft industry and 350 of the firm's staff, there were representatives from Dassault, S.N.C.A.S.E. and S.A.R.M.A. The last-named handle K.A.C. products in France.

Mr. J. McEwan King (chairman and managing director) was his usual energetic self—and, also as usual, apparently as much concerned in "selling" Scotland as he was his own concern's wares. Apart from the more conventional festivities, a hired boat took all the visitors for a trip to admire the Kyles of Bute. The Scotch mist surrounding the Kyles rather defeated this gesture, but solace was to be found in another product of the Highlands.

Speaking after dinner on the Saturday evening, Sir Patrick Dollan (who is chairman of the Scottish Council on Civil Aviation) had high praise for K.A.C. craftsmanship and pointed out that the firm had doubled its size during the past two years. This is quite remarkable when it is remembered that K.A.C.'s turnover is now nearly four times that of its peak war years.

At a little ceremony the same evening, Mr. McEwan King was presented with a gold half-hunter watch by his friends in the industry; and to Miss Harland, secretary of the company, was given a marcasite brooch in appreciation of the efficient manner in which this and many previous parties had been organized.

Foreign visitors and hosts: Gathered together on Dunoon pier during the K.A.C. celebrations are (left to right) J. McEwan King (chairman, K.A.C.) and his piper, C. Burkhill; J. Love (director, K.A.C.); R. E. Witsen-Adelmann (director, S.A.R.M.A.); R. Grangier (S.N.C.A.S.E.); Mrs. Grangier; P. Atlan and J. L. Lagardère (Dassault); Miss Y. Harland (secretary, K.A.C.); I. McEwan King and T. G. Llewhellin (director, K.A.C.). In the background is "Queen Mary II," which conveyed the party round the Kyles of Bute.

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The first air-to-air picture of L.A.V.'s Viscount 749, the second of three for delivery to the South American airline. The first machine flew to Venezuela earlier this month.

CIVIL AVIATION

SIR MILES THOMAS RESIGNS

THE resignation of Sir Miles Thomas, chairman of the British Overseas Airways Corporation since July 1st, 1949, was announced on March 20th with unexpected suddenness. In a letter to Mr. Harold Watkinson, Minister of Transport and Civil Aviation, dated March 7th, Sir Miles wrote: "My feeling is that I have completed the task for which I was commissioned in 1948," adding that he felt he could make a more useful contribution to trade and industry "in other directions." Sir Miles's statement in the same letter that "working in a nationalized industry is not my natural bent," may well provide the real clue to the cause of his resignation. He was subsequently reported to have said in Johannesburg (where he went on March 18th on B.O.A.C. business) that he was tired of "irksome political interference," and "uninformed criticism from back-benchers." There had, he emphasized, been no clash of policy between himself and the Minister; but on the subject of B.O.A.C.'s equipment policy he stated: "You can either have an airline run as a competitive airline and as a keen commercial concern using the best available equipment to keep you up to date with your rivals, or you can have it run as a shop window for British aircraft. But if you choose the second alternative, and run it as a pilot plant for demonstrating goods you would not normally purchase, you must not expect to make a profit."

Sir Miles Thomas.

It seems unlikely that Sir Miles would have been unduly deterred by what he called "uninformed criticism from back-benchers," even though this has been rife in recent months. On March 14th in the House of Commons, for example, the Minister of Transport and Civil Aviation was asked by Mr. Rankin whether he was satisfied with the direction of B.O.A.C., and (by Mr. Beswick) whether there was any reason why the chairman and the deputy chairman should be out of the country at the same time. [Lord Rennell has been out of the country since he left last January soon after his appointment as B.O.A.C.'s Deputy Chairman.] Mr. Watkinson replied that he was well satisfied with the way in which B.O.A.C. was run, and was not aware of "the considerable disquiet," mentioned by Mr. Strauss, "about the recent appointments, about absences abroad, and about the whole general direction given to the Corporation by members of the Corporation." There were also exchanges in the House last November when Sir Miles announced that he was joining the Board of Harry Ferguson Research, Ltd., the motor company.

Sir Miles Thomas is prepared if necessary to continue as chairman until June 30th. A successor of comparable qualities will be hard to find; his achievements while head of the Corporation included the conversion of a £7½m loss in 1948 to a £1m profit in 1953, and the tireless selling of British aviation at every possible opportunity. Sir Miles's resignation is the third from the two Corporations in recent months: Mr. Whitney Straight, formerly deputy chairman of B.O.A.C., was appointed vice-chairman of Rolls-Royce on November 1st, and Mr. P. G. Masefield left his post as chief executive of B.E.A. last November to become managing director of Bristol Aircraft, Ltd.

As reported in last week's "Flight" the Handley Page Herald was inspected recently by Mr. T. H. Davis (second from left), managing director of Piedmont Airlines, U.S.A.

AIRWORK-LUFTHANSA CO-OPERATION

A NEWLY founded German charter company, Deutsche Flugdienst—founded last month with the backing of Lufthansa—will have its flying and maintenance staff trained by Airwork. Several of the British independent's senior captains will shortly go to Germany to begin the training of Deutsche Flugdienst personnel, and to operate the new airline's initial services. Three German pilots are already undergoing preliminary training with Airwork in this country. Initial operations, on a non-scheduled basis (using Vikings), are expected to start next month, Lufthansa being responsible for flight operations and certain ground services.

This is not, incidentally, the first time that Airwork have assisted in the training of a new airline; the company also helped in the formation and operation of Sudan Airways, Misrair and the former Indian National Airways.

CONVAIR'S "MODEL 22" JET AIRLINER

SINCE Boeing and Douglas announced their jet airliner programmes last year there has been much conjecture about Convair's future as a transport builder. The discussions in January with Bristol—resulting in a "mutually satisfactory design specification"—about possible collaboration on the Type 187 BE-25 turboprop airliner seemed to make sound sense, and it therefore came as a surprise to learn that Convair have decided to market a medium-haul jet airliner. The bare information thus far available for the Model 22, as it is designated, makes an interesting comparison—even as to the 1960 delivery date—with the de Havilland Comet 4.

As might be expected of an airliner presumably being bred for U.S. domestic use, the composition of payload and range differs from that of the Comet: 80 to 99 passengers, compared with 58 to 76, for a range of "around 2,000 miles," compared with up to 3,000 miles for the British jet. The 580 m.p.h. cruising speed is considerably higher. Gross weight is 17,500 lb greater at 170,000 lb, although thrust (four General Electric J79s derated from 15,000 lb to 9,000 lb each, as against the four 10,500 R.A.29s of the Comet 4) is substantially less. Empty structure weight, 72,500 lb, is of about the same proportion to gross as the Comet's; the fuselage is seven feet longer at 118ft, and almost certain to be wider. Wingspan is 118ft, 3ft more than the Comet's, and the 35 deg wing sweep—about the same as the 707—indicates that wing area, despite the higher all-up weight, may not be very much more than the Comet 4's 2,121 sq ft.

Convair are aiming at target dates—the achievement of which will be no mean feat—of "late 1959" for the prototype's first flight, with deliveries only a year afterwards. It will be illuminating to watch the response of the American home market to Convair's new project, which closely conforms to the de Havilland philosophy of the need for a medium-haul, medium capacity jet.

Flying time of the Boeing 707 prototype has now passed the 400 hour mark, the aircraft having made 321 flights since the first take-off on July 15th, 1954. Seen here before a recent test flight are, from left to right, R. L. Dix Loesch, Boeing senior experimental test pilot; Joe Frisch, flight test foreman; and Jim Gannett, 707 test pilot.

CIVIL AVIATION . . .

B.E.A./JERSEY AIRLINES AGREEMENT

THE agreement between B.E.A. and Jersey Airlines, now approved by the government, means that the routes between the Channel Islands and between Southampton and Alderney, which have never been profitable to B.E.A., will now be taken over by Jersey Airlines. This operating agreement between the two companies involves also the acquisition by B.E.A. of a 25 per cent shareholding in Jersey Airlines. B.E.A. will continue its main services from London and the provinces to Jersey and Guernsey, as well as those from Southampton to Jersey.

Mr. M. L. Thomas, managing director of Jersey Airlines, said that his company's fleet of three Herons will be increased to seven, the company's three Dragon Rapides being retained for the operation of the shorter inter-island routes. "The company has already established a sound operation reputation and a firm financial background, and it can be confidently expected that the size of the company can be doubled within the next five years." Mr. R. L. Weir, B.E.A.'s financial controller will be appointed to the board of both Jersey Airlines and its parent company, the Jersey Airlines Development Corporation.

SWISSAIR RECALLS 25 YEARS

ON March 26th Swissair celebrated their 25th year of operation. On that day in 1931 two Swiss operators, Balair and Ad Astra, whose origins went back to 1919, joined forces under the name Swissair. The fleet comprised six three-engined Fokker F.VIIBs, two Dornier Merkurs, one single-engined Fokker F.VIIA, one Messerschmitt 18B and one Comte AC-4, operated by a flying staff of nine pilots, four radio operators and eight flight engineers. The two directors of the firm were Walter Mittelholzer, the famous pioneer pilot, and Balthasar Zimmermann. The following year the new airline introduced the four-passenger Lockheed Orion, whose cruising speed of 160 m.p.h.—60 m.p.h. faster than any of its competitors—caused a mild sensation in Europe. Two years later the company were among the first to introduce the historic DC-2. Since the last war, during which Swissair ceased operations, the company has risen to the rank of one of the world's foremost airlines, certainly in efficiency and service if not in sheer size; the present fleet includes six DC-6Bs, eight Convair 440 Metropolitans (due for delivery this year to replace the seven 240s which have been sold), three DC-4s, and nine DC-3s. Four DC-7Cs are on order for delivery this year, and two DC-8s to enable the introduction of trans-atlantic jet services in the spring and summer of 1960. The present Swissair route-network extends to North and South America and the Middle East, and includes every Western European capital city as well as Prague and Belgrade in the east.

Under the energetic direction of Dr. Rudolf Heberlein and Dr. Walter Berchtold, Swissair enters the second quarter century of its existence—as reported in *Flight* the week before last—with a trebling of its share capital—a move which leaves no doubt about the future in store for the carrier of the famous white cross on a red background.

Recalling Swissair's 25th anniversary (see col. 1), this picture shows one of the company's four-passenger Lockheed Orions, HB-LAJ, introduced in 1932 on an express service between Zurich, Munich and Vienna—the fastest of its day.

SILVER CITY'S NEW VENTURE

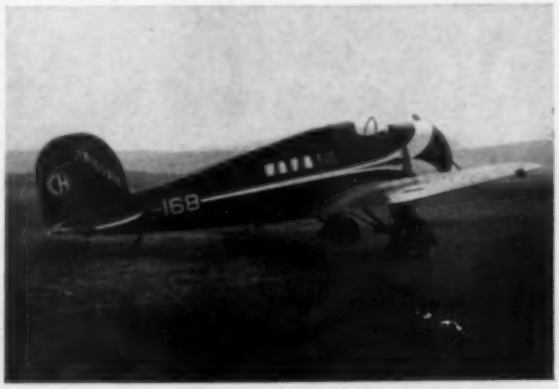
THE name Silver Arrow has been given by Silver City Airways to its new combined road, air and rail service to Paris. Stated to be "quicker and normally cheaper" than existing coach-air or rail-sea-rail services between London and Paris, the operation, which starts in May, will employ three forms of travel: 15 minutes before departure, passengers report at Victoria Coach Station, in central London, to make the three-hour coach journey to Ferryfield, the Silver City airport at Lydd. There they board a Bristol Wayfarer (Freighter Mk 21 converted for passenger-carrying), arriving at Le Touquet 20 minutes later. From there a "Dietrich" Autorail of French National Railways takes over, arriving at the Gare du Nord in the centre of Paris two hours 20 minutes later (an average speed, incidentally, of 65 m.p.h.). The total elapsed time from embarkation in the coach at London to arrival of the train in Paris is 6 hr 50 min, at a return fare of £8 10s. The Silver Arrow services starts with a daily return operations on May 11th, increased to twice daily after May 18th.

Brussels also is included, for the first time, in Silver City's summer programme: a coach-air-coach service will be inaugurated on May 11th, the first of its kind to Belgium. It will be recalled that another British independent, Skyways, inaugurated a coach-air-service between London and Paris last September.

THE COMET 2's C. OF A.

WHEN it was first announced in February 1955 that a number of Comet 2s had been ordered for R.A.F. Transport Command, the Minister of Transport and Civil Aviation stated that the aircraft, before going into service, "will be required to obtain a full passenger Certificate of Airworthiness." This requirement meant that the R.A.F.'s Comet 2s were not only the concern of the manufacturer, the Ministry of Supply, and the Service: the Ministry of Transport and Civil Aviation, as the issuing authority for civil C.s of A. on the A.R.B.'s recommendation, were involved also. Therefore the de Havilland company's task, which has involved the fulfilment of civil as well as Service requirements and the undertaking of full-scale pressure-tank fatigue tests—not to mention fundamental structural modification work carried out on the production line—has certainly not been an easy one. It was the company's hope, nevertheless, as recently as last October, that an all-out programme might enable a full C. or A. to be granted "before the end of 1955," with deliveries to the R.A.F. beginning "early in 1956."

Neither of these hopes has been fulfilled; but although the granting of a C. of A. appears still to be some way off, the newspaper report last week that "the Comet 2 has failed to gain a Certificate of Airworthiness" was misleading. The de Havilland company (although stating that "a C. of A. has not yet been applied for") do not deny that certification tests are taking longer than was expected, pointing out that "there are always small troubles in obtaining a C. of A. and it is untrue to say that there is no chance of one being granted. The matter is still under consideration." The essence of the business seems to be the question of whether the R.A.F., who urgently require initial deliveries for handling trials, training, familiarization, and so forth, can—in accordance with previous civilian practice—receive a new aircraft with a special category C. of A. pending the award of a full certificate. Two of the ten Comet 2s for Transport Command (XK669 and XK770) are flying at Hatfield; three others, unmodified structurally and with a limited cabin life of 2,000 hours, are well advanced in being equipped for "special duties" with the R.A.F.



Although the arrival at London Airport on March 15th of Mr. Georgi Malenkov, former Soviet Premier, was not as spectacular as that of Gen. I. Serov, the Soviet chief of security (see next page), it was nevertheless interesting to renew acquaintance with the Il-14. A new modification, not noted during a previous visit to this country, is the long strake—possibly a structural stiffener—along the top of the fuselage.

BREVITIES

A DISCUSSION of all aspects of air traffic control will take place at Southend on October 4th and 5th under the auspices of the Guild of Air Traffic Control Officers. The convention is likely to include a static exhibition, lectures and opportunities for discussion and the exchange of information.

* * *

Sabena is reported to be considering the purchase of Fokker Friendships for use on the company's routes in the Belgian Congo.

* * *

The M.T.C.A. have bought 16 Collins V.O.R. ground stations, eight for use in the United Kingdom, the others for installation in "various British colonies."

* * *

New B.E.A. appointments include Mr. Alfred A. Pigg to be Manager, France, in succession to the late Colonel Carr; Mr. Geoffrey J. Shannon to be Manager, Switzerland (Mr. Pigg's former post); and Mr. Harry P. Lambe to be Manager, Turkey (Mr. Shannon's former post).

* * *

The official report of the accident to Cambrian Airways Dove G-AKSK in the New Forest on July 23rd, 1955, states that the port engine was mistakenly shut down instead of the starboard engine, which had developed a mechanical fault (a broken crankshaft). The pilot, who was killed, was Capt. R. J. Carson.

* * *

A new international airport for Stockholm is being planned. Located at Jordbro, 14 miles south of the city, the project foreshadows two parallel runways of 10,800ft, plus a supplementary 6,500ft runway. Completion is scheduled for the end of 1959 at a cost of about £10m.

* * *

American Airlines will operate non-stop DC-7 flights between New York and Los Angeles, beginning May 20th, at thrice-daily frequency, which will, it is claimed, provide the fastest connecting service to the U.S. West Coast from Europe. The company will also offer, from April 9th, "the fastest and most direct" coast-to-coast cargo service with DC-6As.

* * *

When asked why K.L.M. had chosen the DC-8 and not the Boeing 707, the airline's president, Mr. I. A. Aler, is reported to have replied: "The ordering of the new jet airliners is 80 per cent a question of trust, and because of a long connection with Douglas, K.L.M. decided to order the DC-8—though the Boeing will certainly be as good an aircraft." Delivery of either aircraft, he added, would depend on the engines: K.L.M. had ordered J75s and no British jet engines would be used. K.L.M.'s DC-8s would be written down in five years.

* * *

Mr. Tom Lucking has been appointed sales representative of Eagle's charter division. Mr. J. Green has been made operations planning officer for the company.

* * *

During a demonstration flight at Hamburg on March 19th in the course of Britannia G-ANBE's European tour, an airscrew hit a runway light during take-off. The aircraft interrupted its tour to return to London on three engines for a replacement.

* * *

Because of an anticipated heavy demand B.O.A.C.'s sixteen Stratocruisers will be used exclusively for transatlantic flights this summer. The New York-Nassau-Jamaica service will be operated by Viscounts of the Corporation's Caribbean associate, B.W.I.A.

* * *

Of the 17,813 aircraft owners in the U.S.A. who have failed to obtain airworthiness certificates since January 1st, 1953, 3,000—in response to a C.A.A. questionnaire—reported their aircraft destroyed or retired; 2,500 were not known; and only 3,700 requested continued registration. The balance either failed to reply or are still being "processed."

* * *

The total fleet of turbine aircraft ordered by U.S. domestic airlines will, says American Airline's president, Mr. C. R. Smith, "fall short of producing the total of service anticipated for 1961." He estimates that domestic airlines will need to produce 55,000m seat miles compared with 31,100m last year, and that about 70 per cent of the 1961 traffic will be carried by the new transports, the remainder by existing aircraft.

* * *

At the annual dinner of the Institute of Transport at the Dorchester Hotel, London, on March 16th, Mr. Harold Watkinson, Minister of Transport and Civil Aviation, recalled that he was the tenth Minister of Transport since the war, and added: "It is not a good thing not to have continuity of administration in a complex industry such as transport." The president of the Institute, Mr. Peter Masefield, was in the chair.

"Flight" photograph

Tu-104 COMES TO LONDON

THURSDAY, March 22nd, was unique; we awoke knowing that we were to see a Russian jet airliner, which was to bring to England Gen. Ivan Serov, head of the Russian security services. Out at London Airport a cold and blustery day turned to rain; but dampened spirits soared at five minutes after noon when the expected aircraft materialized directly overhead. One glance sufficed to tell us that this was a civilianized Badger medium bomber, designated (according to an official pronouncement by General Sakharov, Russia's "D.G.C.A.") Tu-104, being the handiwork of A. N. Tupolev, who is shortly to visit this country.

The graceful machine's first pass took London Airport squarely on the nose, at about 2,000ft on a westerly heading. The procedure let-down took about ten minutes and the aircraft next appeared lined up on runway 15R. The approach was low and slow, with marked changes of heading to counteract the cross-wind. Just as the aircraft passed over the Bath Road the pilot opened up both engines almost to full power; their acceleration was remarkable, and gouts of black smoke streamed from the jet-pipes. The actual touch-down was slow and not particularly nose-up, although the cross-wind caused a considerable amount of drift.

After a run of about 3,000ft the Tu-104 turned off to port and taxied smartly across to its parking place in the Central Area with the flaps retracted, making good use of the steerable nose-undercarriage. Sharp applications of brake caused deflections on the nose leg of several inches; the brakes were quite silent. Once at rest the big machine became a centre of scurrying men and vehicles; and it is worth recording that both engines were opened up to high r.p.m. for some 30 seconds before they were shut down.

Much can be learned from a study of the photographs. The following, however, is provided as a section-by-section résumé of particular points.

Powerplant.—The engines are axial turbojets and the thrust of 6,750 kg (14,850 lb), quoted by one crew-member or passenger, seems reasonable in view of the size of the aircraft and the propelling-nozzle diameter of some 24in. The engines are attached to a sub-structure behind the primary wing members and the jet-pipes are less than 3ft in length. Looking up the "spouts," six rear-bearing support struts are visible. Inside each intake there is a horizontal aerofoil—with a leading-edge intake—extending right across the duct below the centre-line. The whole upper parts of the cowlings are composed of large, excellently fitting panels.

Wing.—The structure seems identical with that of the bomber,

(*Continued on page* 374)

The plan view reveals the considerable sweep of all surfaces — used largely to allow a thick wing with stowage for over 8,000 gal of fuel. This quantity was taken aboard from Esso tankers (above). Insignia comprised a dark blue, red and white cheatline, dark blue lettering and a handsome Red Flag on the fin. The Russian characters painted on the nose signify "T-oo," indicating a Turpolev design.

"Flight" photographs

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The Naval aviators and their ground crews here seen in jovial mood are those of No. 806 Sqn., displaying the Boyd Trophy which they won for 1955. Lt-Cdr. D. P. W. Kelly and Lt-Cdr. P. S. C. Chilton (left and right, holding the trophy) both commanded the squadron during the period for which the award was made. The squadron flew Sea Hawks.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

R.A.F. Anniversary Concert

ON April 7th the Queen and the Duke of Edinburgh will attend the Royal Air Force Anniversary Concert in the Albert Hall. The concert commemorates the foundation of the R.A.F. on April 1st, 1918, and all proceeds will go to the R.A.F. Benevolent Fund.

Conducting of several notable works will be shared by Sir Arthur Bliss, Master of the Queen's Musick; Sir John Barbirolli; W/C. A. E. Sims, the R.A.F.'s organizing director of music; and Mr. Herman Lindars, the well-known choral director. The soloist will be Miss Constance Shacklock and the combined choirs of the Hallé and Sheffield Philharmonic Societies and the Alexandra Choir will take part. Richard Attenborough will act as narrator. It is hoped to make the concert an annual event.

The Duncan Trophy

FOR the first time, a night fighter squadron—No. 87, based at Wahn—has won the Duncan Trophy, awarded annually to the fighter unit in Second Tactical Air Force achieving the best results in air-to-air gunnery training. The trophy was presented to the R.A.F. by Gen. Gervasio Duncan to commemorate his visit to Germany in 1947 when he was Chief of Staff of the Brazilian Air Force. Runners-up to 87 Squadron for the 1955 award were 93 Sqn. at Oldenburg, led by S/L. D. F. M. Browne. Third place was taken by 11 Sqn., Fassberg, led by S/L. E. Batchelar. No. 87 Sqn., commanded by W/C. L. W. G. Gill, flies N.F. 11s.

R.N.Z.A.F. Appointments

THE New Zealand Minister of Defence, the Hon. T. L. Macdonald, has announced that A. Cdre. C. E. Kay will succeed A. V-M. W. H. Merton as Chief of Air Staff, Air Officer Commanding the Royal New Zealand Air Force, and First Member of the Air Board. A. Cdre. Kay will take up his appointment in June, and will be promoted to air vice-marshal.

G/C. R. W. K. Stevens, who is now Director of Postings and Personnel Services at R.N.Z.A.F. Headquarters in Wellington, will take A. Cdre Kay's place as Air Member for Personnel. He will be promoted air commodore.

No. 615 Farewells

AFTER serving with No. 615 Squadron, R.Aux.A.F., for the past nine years, F/L. R. Shillingford was "dined out" on March 15th. He was presented with a silver salver and himself gave the unit a visitors' book with silver inkstand and pen to match. It was, in fact, an evening of presentations; the officers gave a cigarette case to S/L. D'Arcy—who, until recently, was the unit's Regular Adjutant and is now Auxiliary Liaison Officer at Fighter Command—and he gave the squadron a silver salver.

In the course of his speech the C.O., S/L. R. Eeles, announced that No. 615 had been placed third in the Esher Trophy contest—which meant that they had been in the first five over the last four years. The winners this year are No. 500 (County of Kent) with No. 609 (West Riding) in second place.

A popular announcement made during the evening was that the pilots' annual bounty was going up to £50, and that there would be a bonus for airmen for all attendances exceeding 170 hours. It was remarked upon that hard-working "chairborne" officers remain unrewarded.

Reunions

A REUNION for all ranks who served in Aden and outstations, Nos. 8 and 621 Sqns., etc., during 1939-45, will be held at the Chatham Rooms Restaurant, Victoria Station, London, S.W.1 on April 14th. Details from W. Brackenbury, 98 Meopham Road, Mitcham Surrey.

The all - ranks reunion of No. 612 (County of Aberdeen) Sqn., R.Aux.A.F., will be held in Aberdeen on April 21st. Details from the Adjutant, No. 612 Sqn., R.A.F. Dyce, Aberdeenshire.

The horizon reels before the eyes as this CF-100 Mk 4 all-weather fighter of the R.C.A.F. manœuvres over the snow-bound Canadian landscape. These aircraft are to equip some squadrons of the R.C.A.F.'s 1st Air Division in France and Germany.

Tu-104 COMES TO LONDON (continued from page 372)

the sweep angle of some 30 deg allowing a thickness/chord ratio of some 12 per cent, with the maximum thickness about half-way back. The surface tolerance is good, and the well-rounded leading edge shows rivet lines for internal stiffeners every inch or two. There are four large fences and the metal tips carry conventional navigation lights and two vertical slots (presumably de-icing air outlets). There is marked anhedral.

Fuselage.—Remarkably simple, this structure seems to consist of nine sections joined by butt-straps, with almost the entire length pressurized. All riveting is flush. Frames and stringers in the fuselage are numerous, although the skin is applied in large panels of what seems to be something thinner than 18 gauge. The extreme nose is essentially that of the bomber, with an optically flat panel, and the flight deck has flat, sharply raked screens fitted with wipers. A tiny transparent dome (not a light) is mounted in the roof behind the flight deck. Doors are rectangular (rounded corners) and windows circular, the latter being surrounded by doubler plates. Seven windows—three port, four starboard—are mounted in square emergency exits. The interior is divided into several cabins with seating for up to 46 persons. This machine, L-5400, is arranged for V.I.P. transport, but in Aeroflot service standard seating could be greatly increased. Pantries and special radio gear are located above the wing, but the toilets extend almost back to the tailplane, where noise and jet buffet must be considerable.

Undercarriage.—Of Germanic appearance, the stalky bogies retract rearwards into nacelles. Tyre pressure is probably under 100 lb/sq in and the runway loading factor must be low. Structure seems to be of magnesium alloy, there being one main oleo to each bogie, restrained by a drag strut and with an anti-bounce damper mounted forward of the leg to prevent the bogie beam from oscillating. All tyres have a diamond tread and braking seemed most effective, although there is no evidence of anti-skid equipment. As already noted, the twin-wheel nose unit is steerable.

Tail Unit.—All surfaces are swept at about the same angle as the wing, and there are no intakes or "turbulators." The fixed tailplane is mounted on the fuselage and has very slight dihedral (on the bomber it is mounted on the fin).

Control Surfaces.—Elevators and rudder are mass-balanced and shrouded and have tabs. The ailerons have small tabs and appear to be sealed. Hinges are everywhere inset, the leading portion of each movable surface being relatively thin. Fully powered control seems unlikely, but power boost is probable. The flaps are of considerable chord. There is one flap portion between each aileron and undercarriage nacelle and one portion inboard of each nacelle.

Radio.—From the number and type of aerials distributed about the airframe we would judge the Tu-104 to be generously—even lavishly—equipped with electronics. Since the nose of the machine appears to be entirely military, it seems possible that the radar scanner housed behind a small grey dielectric blister under the nose is, in fact, the bombing aid of the military version. For civil operations it could well be adapted as a map-painting aid to navigation—its assistance might well prove very useful over certain parts of Russia. It seems unlikely that this radar would prove entirely satisfactory for turbulent cloud-spotting purposes.

It may be assumed that since the war the Russians have developed navigation aids of their own, probably based to some extent on the German Lorenz and Consol systems, i.e., a beam-type approach aid and a lattice position-fixing system. Certain of the aerials carried by the aircraft at London Airport appeared suitable for these two types of radio. In addition, both the Il-14 which visited London the previous week and the Tu-104 carried stick and T-shaped aerials under the fuselage and horizontal tail surfaces which could be used for something equivalent to D.M.E. or V.O.R. and for radio height-finding. It seems likely that the Tu-104 has both D.M.E. and radio-altimeter equipment. For operations in Russia, a fair variety of communications radio would probably be needed; here again, wire, stick and whip aerials suggest that H.F. and V.H.F. radio is fitted, with the possible addition of M.F. Absent is any form of D.F. loop equipment, though this may, of course, be fitted somewhere inside. The only integral aerial is one housed in the plastic tip of the fin.

Conclusions that can be drawn are, first, that almost every type of radio and radar equipment helpful to normal operations was being carried, and secondly, that a good deal of equipment utilized comparatively clumsy aerials—though several of these may have been fitted only in prototype form or just for this flight. It was interesting to see such a fast aircraft so festooned with un-aerodynamic and eminently ice-prone appendages. Finally, the large number of aerials may well indicate liberal duplication of equipment, conforming either to Western airline practice or pointing to poor equipment-reliability.

Miscellaneous.—No air brakes could be seen, but twin doors under the tail almost certainly cover a box for a braking parachute. Instead of static-discharge wicks the aircraft was fitted with spikes, one of which was attached to the tip of each control surface.

Conclusion.—Bad weather along the route from Tushino Airport, Moscow, had not worried the crew, who selected a cruising altitude of 10,000m (32,800ft) for the 3 hr 36 min flight. Those who went aboard noticed oxygen points, possibly signifying an undeveloped pressurizing system. The aircraft, which was to remain at L.A.P. for at least two days, took 60,000 lb of kerosine aboard, hoses being applied to sockets in the upper leading edge adjacent to the engines.

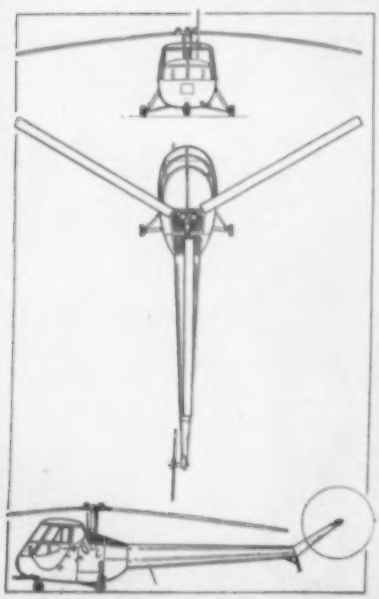
Tail-piece: At 12.27 p.m. a P.R. Canberra (WT512) came crabbing across at about 150 knots.

Tu-104 Provisional Data: Two 15,000 lb-thrust axial turbojets, reported to be designated M-209. Span and length, over 100ft; maximum weight, about 120,000 lb; wing loading, about 75 lb/sq ft; cruising performance, over 2,000 statute miles stage length at about 500 m.p.h. t.a.s.

SAUNDERS-ROE SKEETER (continued from page 359)

push rod. A crossbar is bolted to the push rod and is connected by links to the pitch-control arm of each blade. Movement of the crossbar by the jack simultaneously varies the pitch.

The "fly-off" rotor-brake lever is mounted on top of the control-box structure between the pilots' seats, and is connected by Bowden cable to the brake-drum on the tail-rotor transmission shaft. The brake is applied by pulling the lever downward and is held in this position by a spring cable which also prevents operation of the cartridge-starter until the brake is released. Also fitted on the central structure are the fuel and oil on-off switch, mixture control, engine starter lever, and Ki-gass primer.

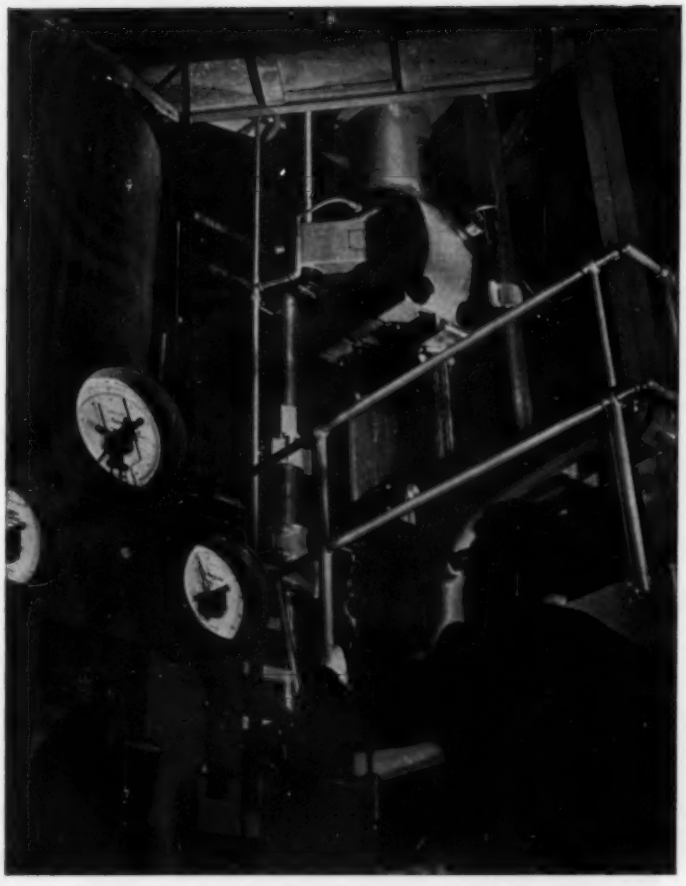


Protruding from beneath the re-designed instrument panel are two "parking brake"-type handles. That on the port side is indeed the main-wheel parking brake; the starboard one is the manual over-ride control for the centrifugal rotor-engaging clutch. To avoid the possibility of overspeeding the engine during the starting cycle, which would cause the clutch to engage suddenly and throw a heavy impact load on to the transmission and blades, the engine is normally started with the manual over-ride (disengaging the clutch) in operation. When the engine is running smoothly below the normal clutch-engagement speed, the manual over-ride is released. The engine speed is gradually increased and the clutch engages gently under the influence of the controlling centrifugal weights.

For the A.O.P. rôle, the Mk. 10 Skeeter will carry an Army Type A.62 H.F. communications set, mounted on the cabin floor between the pilots' seats. The port seat in this version is reversible, a rear foot-well being incorporated in the cabin structure.

The Mk. 11 trainer for the R.A.F. will be fitted with a Plessey PTR.61H V.H.F. set, as shown in the cockpit photograph and the cutaway drawing. The Perspex roof-panels of the canopy in both versions will be clear and not amber as on previous Skeeters. Another modification to the canopy as fitted to earlier types is the deletion of the front direct-vision panels in favour of the sliding window-panels of the doors.

It is reported that both the A. and A.E.E., Boscombe Down, and the R.A.F. Central Flying School were most favourably impressed by the Skeeter 6 during evaluation tests last year. Boscombe pilots consider the Mk. 6 a pleasant aircraft to fly, and able to operate in relatively severe wind conditions; while C.F.S. believes the machine to be not only superior to other helicopters of its class, but ideal as a training helicopter for the Services. Certainly the Skeeter is capable of absorbing still higher engine powers, with corresponding improvements in payload and performance; and an appreciable improvement will come with the finally developed metal blade, independently of the powerplant situation. Total flying time logged by Skeeters up to last week was 503 hr, in addition to 364 hr of ground-running.



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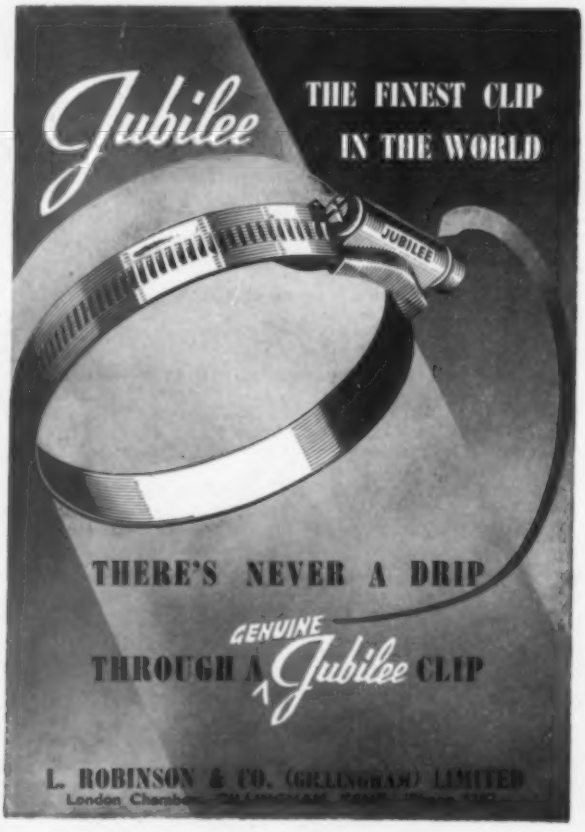

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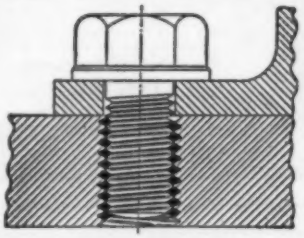

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PUBLIC ANNOUNCEMENTS

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THE AIR TRANSPORT ADVISORY COUNCIL give notice that they have received the undermentioned applications to operate scheduled air services: From Eagle Aviation, Ltd., of 29, Clarges Street, London, W.1, for the following Seasonal Inclusive Tour Services in conjunction with Sir Henry Lunn, Ltd., for the carriage of passengers and supplementary freight at a frequency of four return flights weekly on each service, for a period of seven years from the Spring 1957:—

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APPLICATION No. 749 for a service between London (Blackbushe) and Munich (Riem) with Viking and/or Dakota aircraft during the season from May to October inclusive each year, commencing 1st May, 1957.

APPLICATION No. 750 for a service between London (Blackbushe) and Pisa (San Giuste) with Dakota and/or Viking aircraft during the season from April to October inclusive each year, commencing 1st April, 1957.

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THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, Westminster, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [5033

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(l) Draughtsmen (senior, intermediate and junior) for the design of electrical and radio systems, instruments, structures, power plants, installations, mechanism, furnishing, etc. Aircraft experience not essential.
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for both strength and flutter calculations.

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well known Aircraft Company.

APPLICANTS should have wide experience of trade union negotiations, labour relations, apprentice training schemes and selection and engagement of all types of personnel. Some previous experience in the engineering industry essential. The position carries executive responsibility and is pensionable. Please write stating full details of experience, age and salary required to Box F. 879, c/o 191, Gresham House, E.C.2. [5036

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PERSONNEL Manager, Eagle Aircraft Services Limited, Blackbushe Airport, Camberley, Surrey. Telephone: Yateley 2371. [4976

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STRESS ENGINEERS

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This vacancy offers unique experience and interest, and salary will be commensurate with experience and qualifications.

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SITUATIONS VACANT

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WARDEN AVIATION, Old Warden Aerodrome, Biggleswade. Tel. Northill 288. [4996

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SENIOR Design Draughtsman, accustomed to working with the minimum of supervision, required for Aircraft Component Department. Aircraft experience preferred but not essential. Salary in accordance with experience and qualifications. Reply in writing to: King Aircraft Corporation, Fifth Street, Montrose Ave., Hillington, Glasgow, S.W.2. [0420

ENGINEER or Physicist required for interesting and varied work on a wide range of problems associated with cooling and heat transfer on electronic equipment. Post-graduate experience of this type of work or in the desgin of heat exchangers, air blowers or refrigeration is desirable, but not essential. Some mathematical ability will be needed.

APPLY in writing, stating age and experience, to The Staff Manager, G.E.C., Stanmore Laboratories, Stanmore, Middx, quoting Ref.: LMKB/DTM. [4974

TECHNICAL Clerk (B.I.S.), of reasonable educational level with an aptitude towards engineering. Must be capable of understanding assembly schedules and able to read drawings. Duties will include the compilation of technical build instruction sheets for assembly and test work. Training will be given to suitable candidate.

PLEASE write in detail, quoting Ref. 100, to:—The Personnel Manager (Technical Employment), de Havilland Propellers Limited, Hatfield, Herts. [4979

SECTION Leader with electrical and mechanical experience for installation work on aircraft fire and explosion protection. Pleasant surroundings, good canteen facilities, easy access to buses, Green Line and trains. Please apply to Chief Draughtsman, Graviner Manufacturing Co., Ltd., Poyle Mill Works, Colnbrook, Bucks. Tel.: COLnbrook 48. [4968

KING AIRCRAFT CORPORATION require Senior, Intermediate and Junior Draughtsmen, and Stress Engineers, at their Central Glasgow Design Offices for work on an expanding programme of interesting and important projects of an advanced nature. Good salaries and conditions, forward details of previous experience to:—Personnel Officer, King Aircraft Corporation, Hillington, Glasgow, S.W.2. [0422

DESIGNERS. First class senior designers are required for interesting work on the design of gas turbine fuel systems and controls. These appointments offer excellent opportunities to the right individuals but only first class senior designers need apply. Applications to be sent to Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham, 28. [5035

SCOTTISH AVIATION have immediate vacancies for aircraft stressmen and aerodynamicists for work on the Prestwick and Twin Pioneer aircraft. Excellent prospects for experienced men. New houses are also immediately available. Applicants should reply in writing giving details of experience and training to the Personnel Manager, Scottish Aviation, Limited, Prestwick Airport, Ayrshire. [4911

SCOTTISH AVIATION urgently require Planning Engineers for work on their Prestwick Twin Pioneer project. Applicants should have served a recognised Engineering Apprenticeship and have previous Aircraft Planning experience. Houses immediately available. Reply giving details of training and experience to Personnel Manager, Scottish Aviation, Ltd., Prestwick Airport, Ayrshire. [4858

SITUATIONS VACANT

ENGINEERS, licensed on S.51 and S.55 helicopters, and aircraft fitters, preferably with helicopter experience required for operations in this country and overseas. Apply giving details of experience, age, etc., to Bristow Helicopters Limited, Henstridge Aerodrome, Templecombe, Somerset. [5030

STRESSMEN in all grades required. Salaries range from £500 p.a. to £1,100 p.a. Qualifications required: H.N.C., Certificate of Education (Advanced Level), B.Sc. Engineering, Mathematics or Physics. Previous experience not essential but will be taken into account when fixing salary. Application forms from Chief Stressman, Electro-Hydraulics Limited, Liverpool Road, Warrington, Lancs. [4956

DESIGNERS. First class senior designers are required for interesting work on the design of gas turbine fuel systems and controls. These appointments offer excellent opportunities to the right individuals but only first class senior designers need apply. Applications to be sent to Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham, 28. [4959

AERODYNAMICIST required for our London Office. Candidates should be 24-28 years of age, with a good degree and some experience of supersonics. Duties will be of a varied nature, including thermodynamic work and liaison with Trials teams. Please write in detail, quoting Ref. 118, to:—The Personnel Manager (Technical Employment), de Havilland Propellers Limited, Hatfield, Herts. [4978

SENIOR qualified development engineers and technicians required in research department of a well-known firm of precision engineers, particularly for work in connection with Servo systems, small precision motors and gyroscopic control systems. Apply stating age, qualifications, experience, and salary required to S. G. Brown, Ltd., Shakespeare Street, Watford, Herts. [0146

ARMSTRONG Siddeley Motors has a vacancy for a flight test observer in connection with flight testing gas turbine engines. Applicants should have a Degree or equivalent in either Mech. or Aeronautical Engineering. Previous flying experience not necessary. Selected applicants will be required to undergo a medical examination. Good salary offered dependent on age, experience and qualifications. Applications to Reference FL/T, Armstrong Siddeley Motors, Coventry. [0472

GRADUATES in Science or Engineering for development work on gas turbine fuel systems for aircraft and commercial projects. Training will be given if required to personnel newly qualified. These vacancies are pensionable and offer opportunities for individuals to progress to senior appointments in a new and rapidly expanding company. Applications should be made to the Personnel Manager, Joseph Lucas (Gas Turbine Equipment), Ltd., Shaftmoor Lane, Hall Green, Birmingham, 28. [5034

WEAPONS-SYSTEM Assessment. Technician required for work on weapons-system studies. Previous knowledge of this subject an advantage but not essential. Applicants should have the ability to tackle new problems. Knowledge of mathematics to about degree standard and a background of aeronautical engineering experience is desirable. Write stating age, experience and salary required to:—Staff Officer, Handley Page, Ltd., Cricklewood, London, N.W.2. [4885

ARMSTRONG SIDDELEY MOTORS, Coventry, require an Assistant Technical Engineer for project work. This is a unique opportunity for a young man with some technical qualifications to enter the most interesting side of the gas turbine field. The position gives full scope for technical ability, entailing investigations and design calculations on many advanced and challenging projects. Applications with full details of age, qualifications and experience, if any, to the Technical Personnel Manager, Armstrong Siddeley Motors, Coventry, quoting 'Projects 1.' [0464

WANTED, draughtsmen to design in aluminium for sales development. Must possess Higher National Certificate in Mechanical Engineering. Location Banbury. Good working conditions and pleasant surroundings. Attractive starting salaries offered up to £800 p.a. with prospects of promotion from drawing board. Pension plan in operation. Send brief details of qualifications and experience to Northern Aluminium Co., Ltd., Bush House, Aldwych, London, W.2. [0348

SCOTTISH AVIATION urgently require Draughtsmen and Designers for work on their Prestwick Twin Pioneer and other new projects. Applicants should have served a recognised Engineering Apprenticeship and have previous experience in the Aircraft Industry. Excellent conditions and pension scheme in operation. Houses immediately available. Reply giving details of training and experience to Personnel Manager, Scottish Aviation, Limited, Prestwick Airport, Ayrshire. [4859

THE Aerodynamics Department of Armstrong Siddeley Motors has vacancies for both Senior and Junior Development Engineers for work on axial flow compressors, turbines and general airflow. A Degree in Mechanical Engineering and previous experience in this type of work an advantage. Initial salaries range from £650-£1,050 per annum dependent on age, experience and qualifications but superscale rates would apply to senior experienced men. Excellent prospects and good pension fund. Applicants should give full details quoting Reference Airflow 2, to Technical Personnel Manager, Armstrong Siddeley Motors, Coventry. [0466

VACANCIES arise for good practical electronics engineers in a new department being set up to handle the overall assessment of reliability in the field of Guided Weapons. One or two of the positions offered will be senior appointments and the work will entail the collection of data, pursuit and analysis of faults at all stages from complete assembly down to basic detail. A short period of familiarisation with the equipment involved will be arranged. Please write, in confidence, quoting Ref. 117, and giving full details of age, qualifications and previous experience, to:—The Personnel Manager (Technical Employment), de Havilland Propellers Limited, Hatfield, Herts. [4977

ROCKET Division of Armstrong Siddeley Motors has really good vacancies for designers and draughtsmen intent on furthering their career in this new branch of propulsion. Applicants must have had minimum of three years drawing office experience and preferably hold at least a Higher National Certificate in Mechanical Engineering. Drawing Office experience however is preferable to academic qualifications. Due to new projects and consequent expansion of departments prospects for men of the right calibre are unusually good. This is a fine opportunity to enter on the ground floor of new and fascinating work with far reaching implications. Initial salary range £13 10s. to £16 10s. per week. Apply for a personal interview with our Chief Designer, Rocket Division, by writing to Technical Personnel Manager, Armstrong Siddeley Motors, Coventry, quoting reference RD/DD. [0469

ASSISTANT Signals Officer required by Sierra Leone Government Civil Aviation for two tours each of 18/24 months. Appointment will be either (a) on contract with salary scale (including Expatriation Pay) £859 rising to £1,359 with gratuity up to £150 a year or (b) with prospect of pensionable employment with salary scale (including Expatriation Pay) £797 rising to £1,257 a year. Outfit allowance £60. Liberal leave on full salary. Free passages for officer and wife. Assistance towards cost children's passages or grant up to £150 annually for maintenance in U.K. Candidates should be experienced MF, HF, VHF, VHF/DF and ancilliary equipment and should hold P.M.G. Cert. or equivalent. Preference for C. & G. Cert. in Radio. Write to the Crown Agents, 4, Millbank, London, S.W.1. State age, name in block letters, full qualifications and experience and quote M2C/41565/FE. [5020

WELL known Midland aero engine company requires Mechanical Engineering Designers and Draughtsmen to join teams on various aspects of engine construction. Initial salary £650-£1,000 per annum. Owing to expansion in new drawing offices, with excellent working conditions, departments will offer good prospects to men with initiative. Sickness benefits for families and pension fund. Full details quoting Reference AD/R to Box 8565. [0467

HANDLEY PAGE (READING), LIMITED, The Aerodrome, Woodley, Reading, Berks, have vacancies for Senior Stressmen for interesting work on Civil Aircraft. High commencing salaries will be paid and new houses to rent will be offered to successful applicants. Also required are Senior and Intermediate Design Draughtsmen and Weights Engineers. Superannuation and Life Assurance Scheme is in operation for all staff employees. Please send full particulars of experience, etc., to the Personnel Officer. [0280

YOUNG Engineers required by Armstrong Siddeley Motors for work on gas turbine aero engine performance prediction, flight analysis and associated problems connected with the flight development of engines. Degree, or equivalent required, a mathematical bias an advantage. Previous experience of this type of work desirable but not essential. Good salaries and pension scheme. Applications, with full details of age, experience and qualifications to Reference FL/P, Technical Personnel Manager, Armstrong Siddeley, Coventry. [0471

TECHNICAL Authors (Senior, Junior and Intermediate), must be capable of reading engineering drawings. Duties will include the preparation of descriptive and instructional literature on a wide range of subjects—mainly mechanical and hydraulic. Knowledge of methods of print production and associated processes an advantage. Instruction given in Junior post which is intended to be progressive. Please write in detail, quoting reference number 19, to:—The Personnel Manager (Technical Employment), de Havilland Propellers, Ltd., Manor Road, Hatfield, Herts. [0421

BRITISH WEST INDIAN AIRWAYS Limited invite applications from qualified Navigation Instructors to fill an immediate vacancy in Trinidad. The successful applicant must be capable of conducting courses up to A.L.T.P. standard for pilots and Operations II Course for Station Officers. He must be capable of deputising for the Navigation Superintendent when necessary. Knowledge of aircraft performance and flight manuals would be an advantage. Salary in the scale BWI$450 to BWI$550 per month depending upon qualifications, plus Cost of Living Allowance of BWI$43.12 per month. Generous Provident Fund in operation. Two weeks local leave per annum, three months U.K. leave after each period of three years overseas. Applications to Personnel Officer (Associated Companies), B.O.A.C. Headquarters, P.406, London Airport, Feltham, Middlesex. [5017

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PILOT, 37 years old—over 8,000 hours in comm. and (DC-3 6,000 hours) all flying accident free. Current British A.L.T.P. and Flight Navigator Licences. Box No. 0846. [5039

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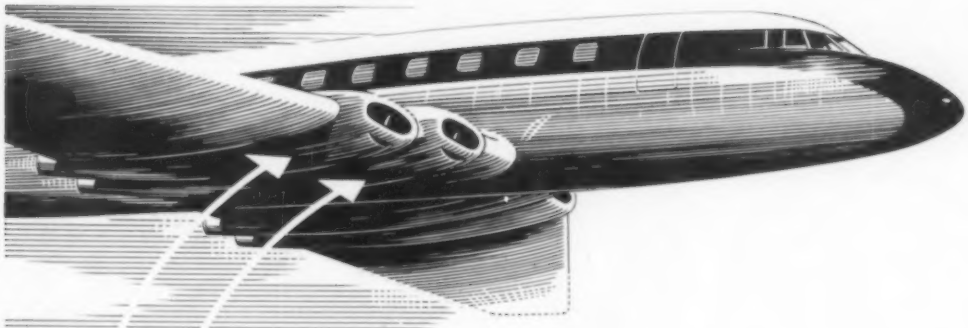

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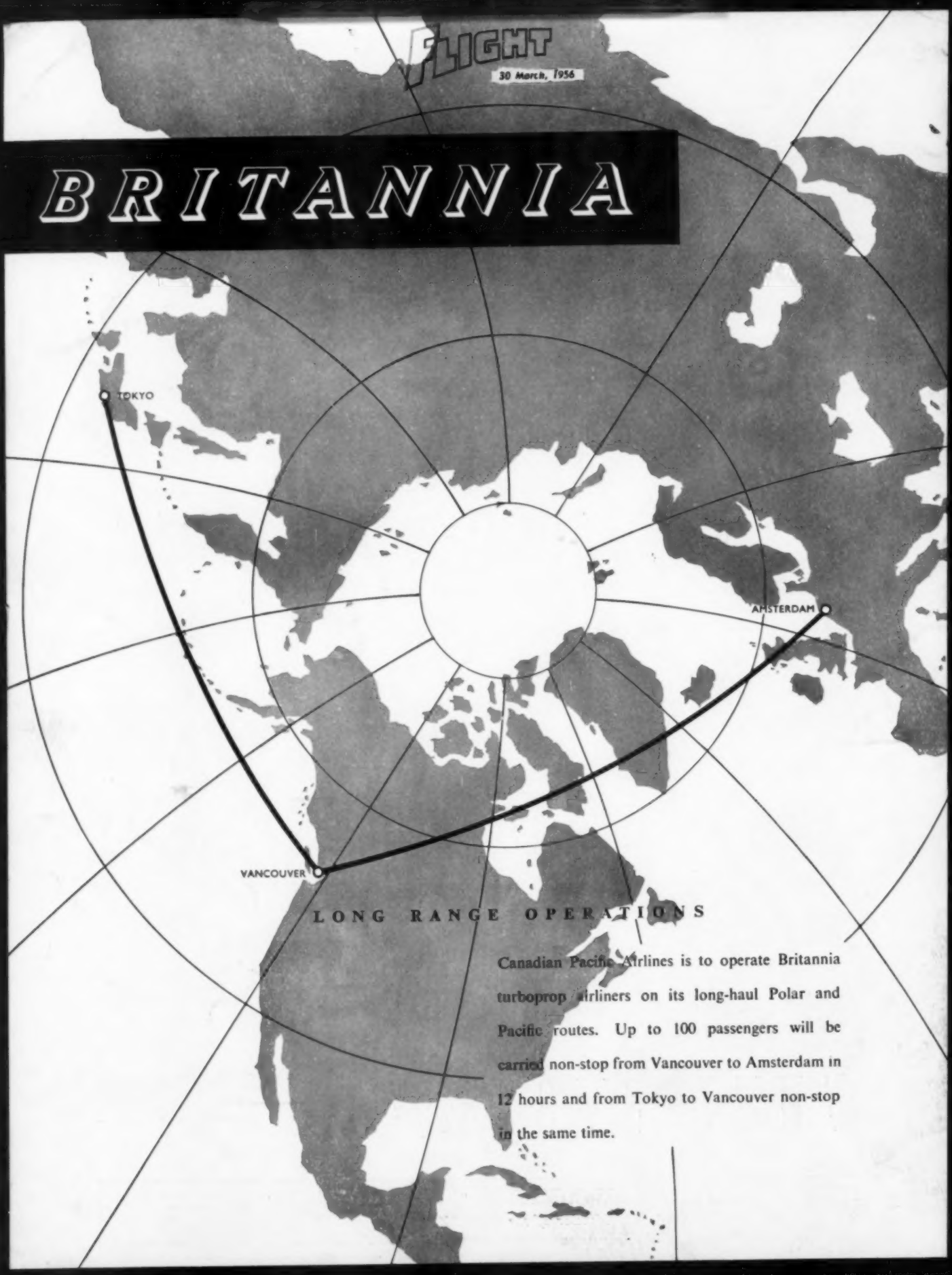

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